

1. Core Monitoring Objectives - Sampling & Analysis Plan
2. Monitoring to Measure Loads and Flow

2nd Stakeholder Meeting
May 23, 2018

Dave Armstrong, Alana Spaetzel
New England Water-Science Center
U.S. Geological Survey, Northborough, MA

Core Monitoring Objectives:

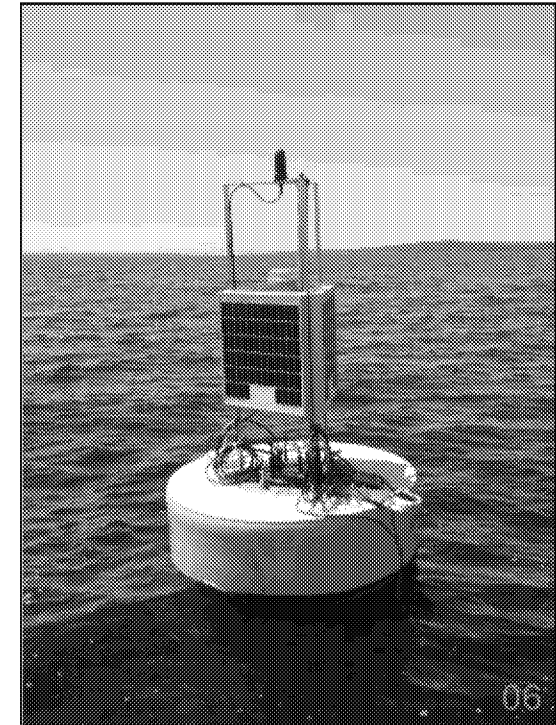
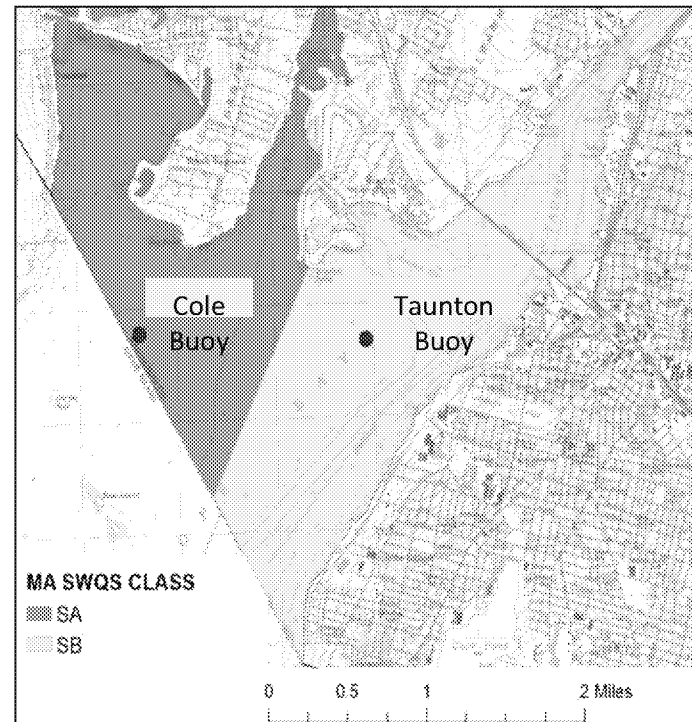
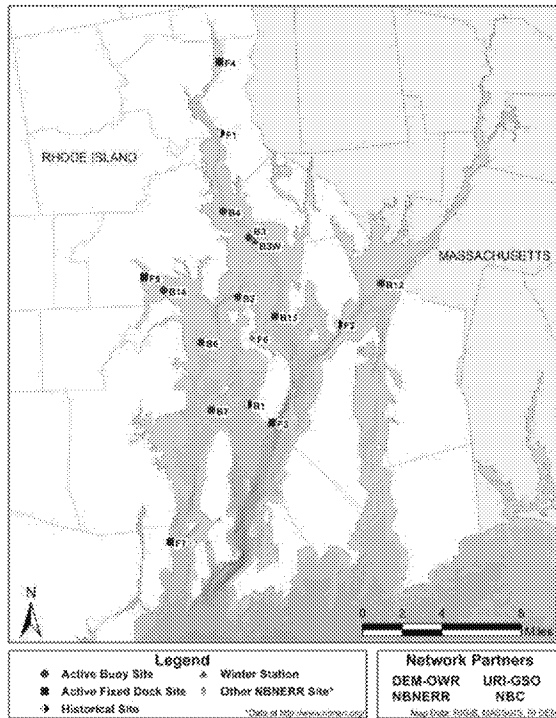
1. Support DEP review of marine dissolved-oxygen criteria
2. Assess waterbody compliance to water-quality standards
3. Delineate salt wedge in Taunton estuary
4. Estimate nutrient loads into Taunton estuary

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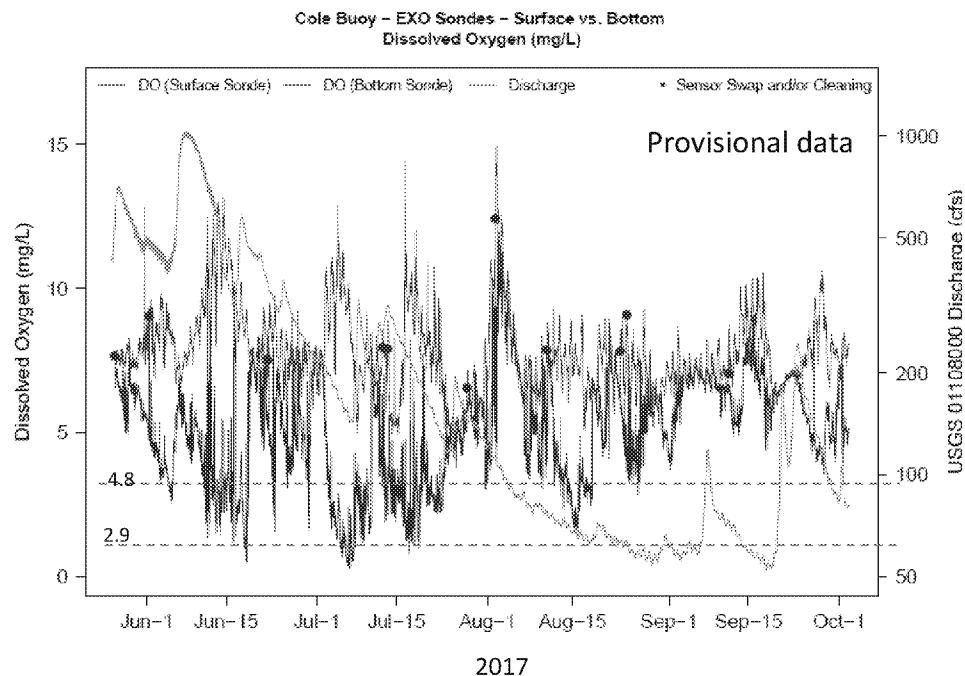
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- MassDEP funded the Mt Hope buoys to collect data that could be used to help develop a marine DO methodology for Massachusetts.
- The buoys expand URI and RIDEM's Narragansett Bay Fixed-Site Monitoring Network into the MA portion of Mount Hope Bay.

Narragansett Bay Fixed-Site Water Quality Monitoring Network Locations



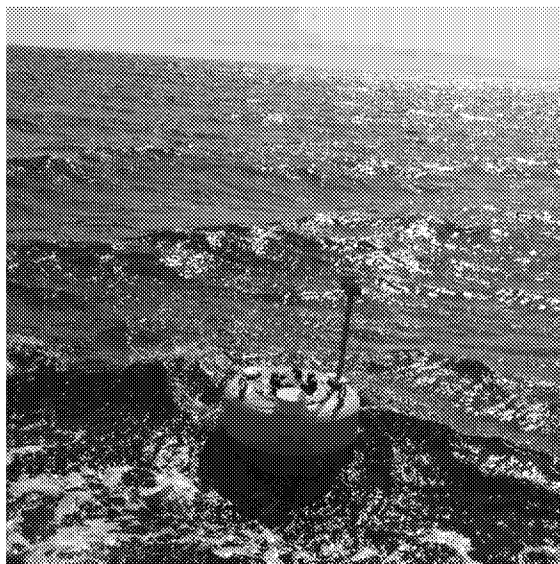
- The draft marine DO criteria will require continuous-data collection to assess the intensity, frequency, and duration of DO conditions
- Additional continuous-monitoring data is needed
 - A. To assess how well the Cole and Taunton buoys represent DO conditions in Mount Hope Bay
 - B. To provide more vertical resolution of DO conditions in the Bay, and
 - C. To assess DO conditions in the Taunton River Estuary, and in the Cole and Lee River estuaries



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An additional goal of the network would be to provide accurate data to help track future hypoxic events and evaluate effects of WWTF upgrades that are expected to reduce nutrient loadings to the Bay.

- **(A) Buoys collecting**
(Temp, Cond, salinity, TDS, pH, DO, Turbidity, chlorophyll_a)



- **(B) Deploy arrays of DO dataloggers**

The PME miniDOT Loggers measure dissolved oxygen and temperature.



- **(C) Vertical water column profiles**
(DO, temperature, Cond, salinity)



- Locations for data collection – considered areas where data had been collected historically.

For example, by the Coastal Systems Laboratory of the School of Marine Science and Technology (SMAST) University of Massachusetts – Dartmouth during 2004-2006

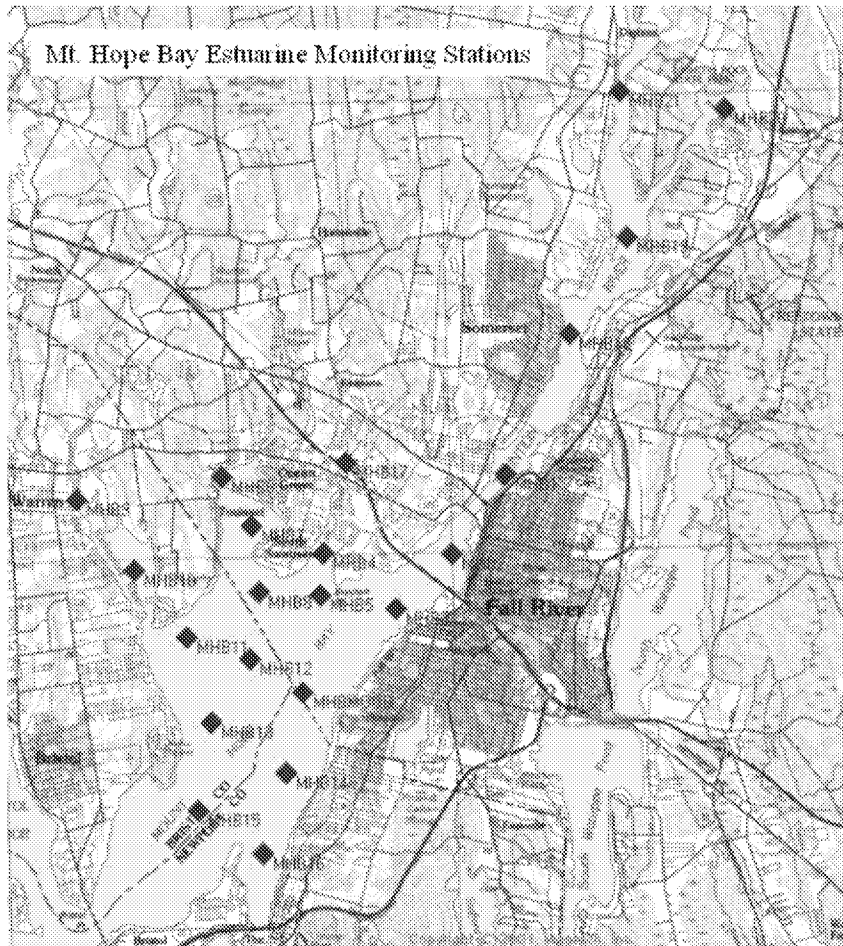
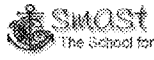


EXHIBIT J
AR J7



University of Massachusetts - Dartmouth
The School for Marine Science and Technology

DEP #2004-04/604
DEP #2005-05/604
DEP #2006-04/604

**Summary of Water Quality Monitoring Program
for the Mount Hope Bay Embayment System
(2004 – 2006)**

(Final August 16, 2007)

Mt. Hope Bay – Estuarine Water Quality Monitoring 604(b) Grant

Submitted to:
MA Department of Environmental Protection

By:
Dr. Brian Howes
Roland Samimy

Coastal Systems Laboratory
School of Marine Science and Technology (SMAST)
University of Massachusetts – Dartmouth

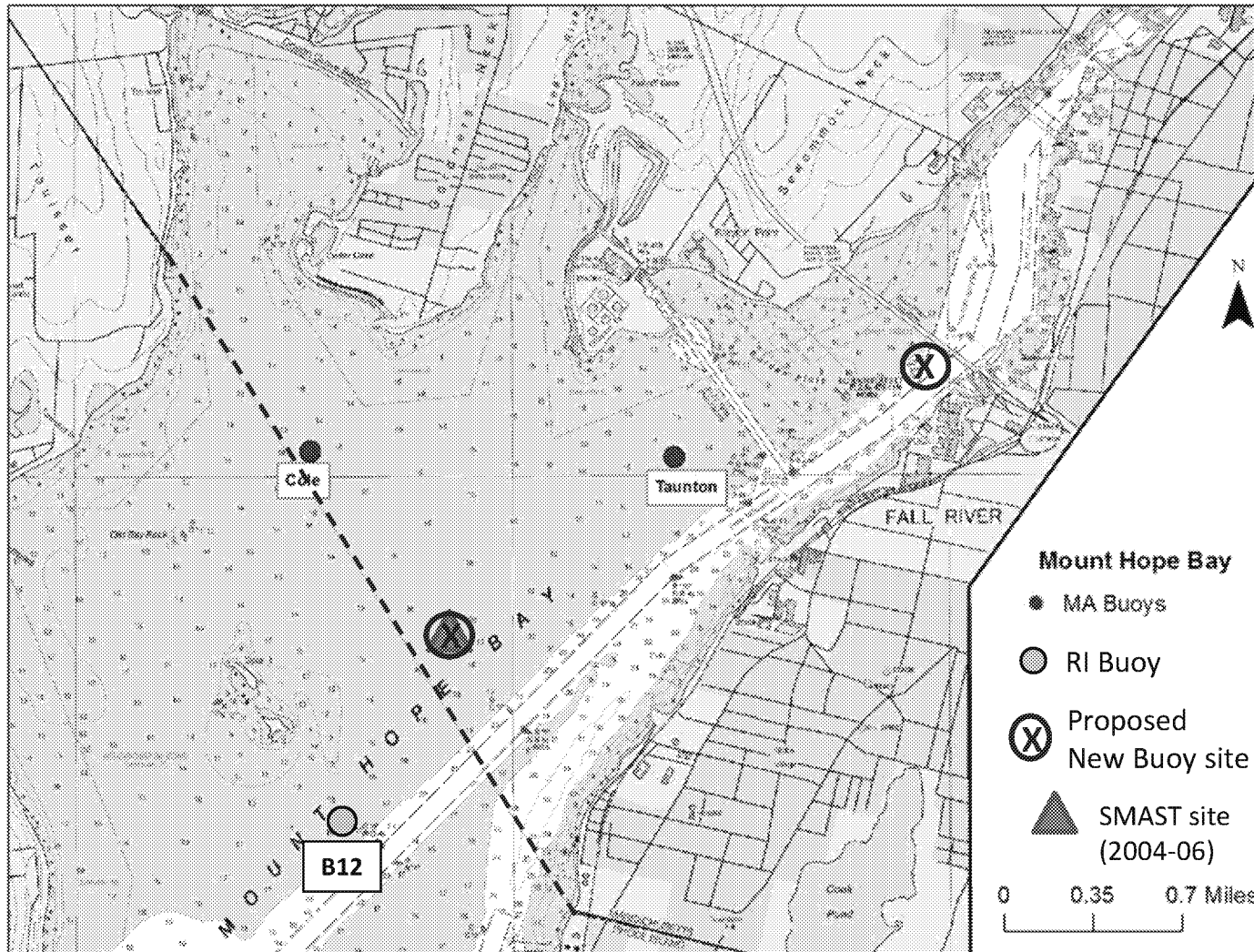
For:
Southeastern Regional Planning and Economic Development District (SRPEDD)

and the
MA DEP 604(b) Program

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(A) Additional buoys in Mount Hope Bay and the Taunton Estuary

- 1, 2. Additional buoys in Mt Hope Bay, between the Cole and Taunton Buoys, and in the lower Taunton Estuary (between the Somerset and Fall River WWTF's)



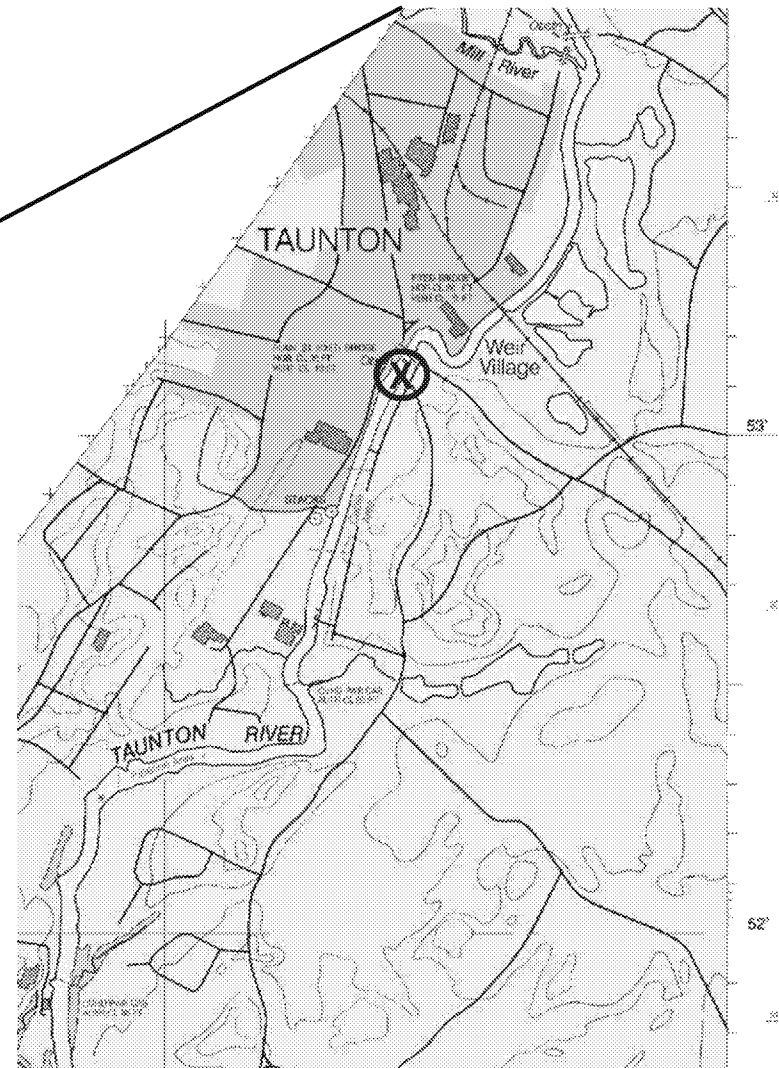
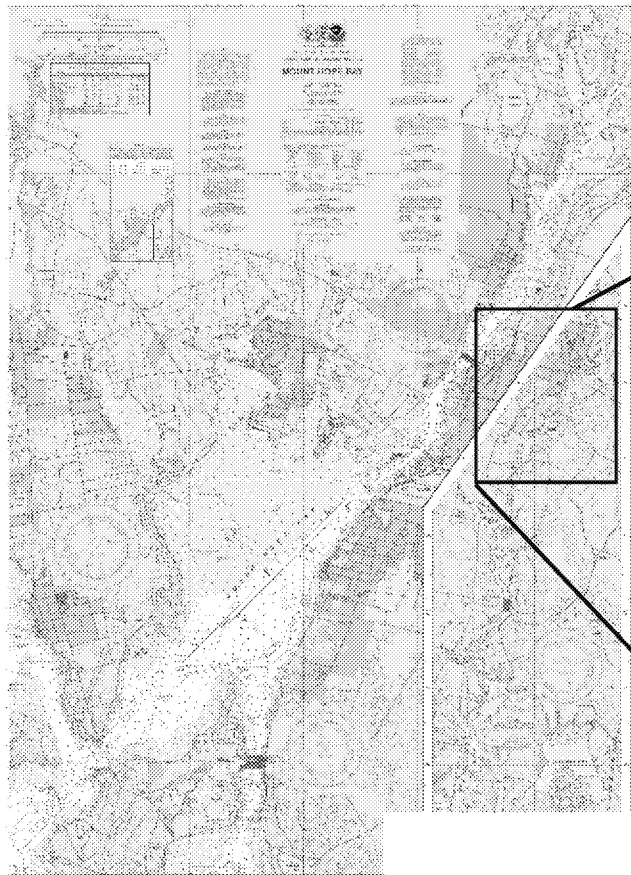
(A) Additional buoys in Mount Hope Bay and the Taunton Estuary...

3. An additional buoy in the middle Taunton Estuary, downstream of the mouth of the Assonet (and between the Somerset and Taunton WWTF)

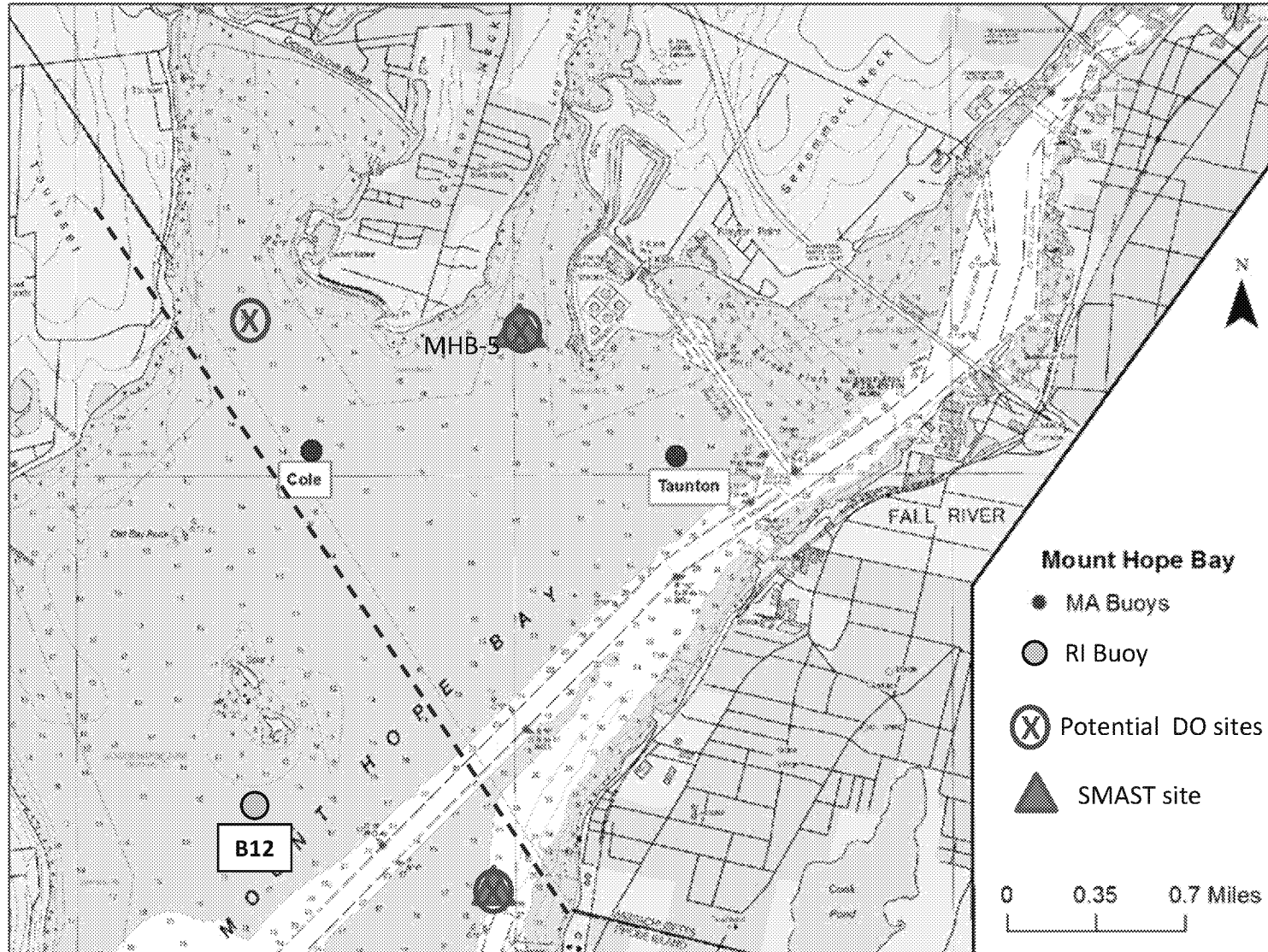


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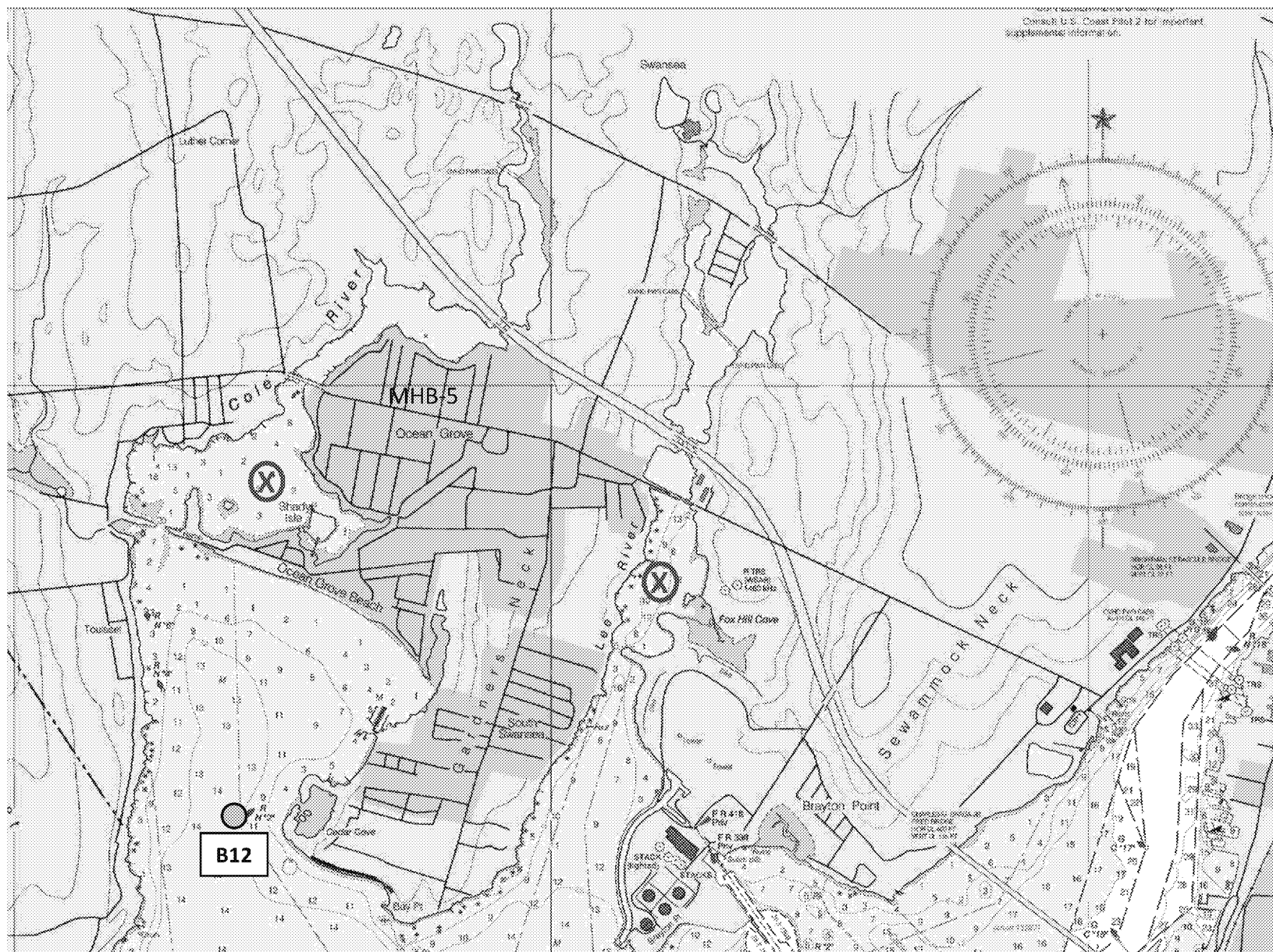
4. An additional buoy or sensor in the upper Taunton Estuary near the saltwater-freshwater interface (and upstream of the Taunton WWTF)



(B) DO sensors (top/middle/bottom) could be added at additional locations in the Bay at the mouth of the Cole and Lee Rivers, (and down-bay from the Fall River WWTP)



(B) DO sensors (bottom-only) could also be added at locations in the Cole and Lee Rivers

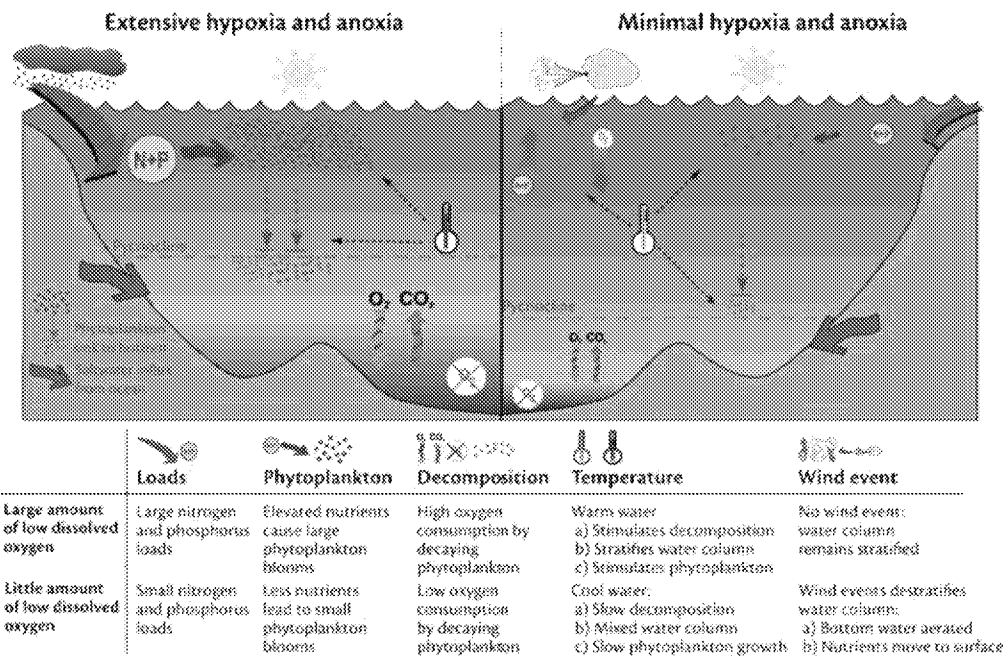


(C) Collect vertical profiles at fixed locations in Mount Hope Bay between and around MassDEP buoys (Cole and Taunton) and NBFSMN buoy (B12), and DO sensors, during routine maintenance, to assess DO conditions and stratification.



(C) Profiles would be collected during maintenance, but could also target particular conditions:

- Measured during different portion of the tidal cycle during the same time period (low/slack high in August)
- During the same portion of the tidal cycle over the course of several months, such as during neap tides in July, August and September
- Event based vertical profiles triggered by wet or dry weather, or low wind conditions



Oxygen demand coupled with warm waters and density stratification increases the risk of hypoxic conditions in the summer months, especially during periods of with higher freshwater discharges, and during neap tides when tidal mixing is low and (Prell 2015).

Historic data: The “Insomniacs” conducted night-time surveys in Narragansett Bay in the summers of 1999 to 2003 that included 13 Surveys of a transect across Mount Hope Bay (Prell and others, 2004). Data from vertical profiles was used to plot DO conditions in the Bay (Desbonnet and Costa-Pierce, 2008)

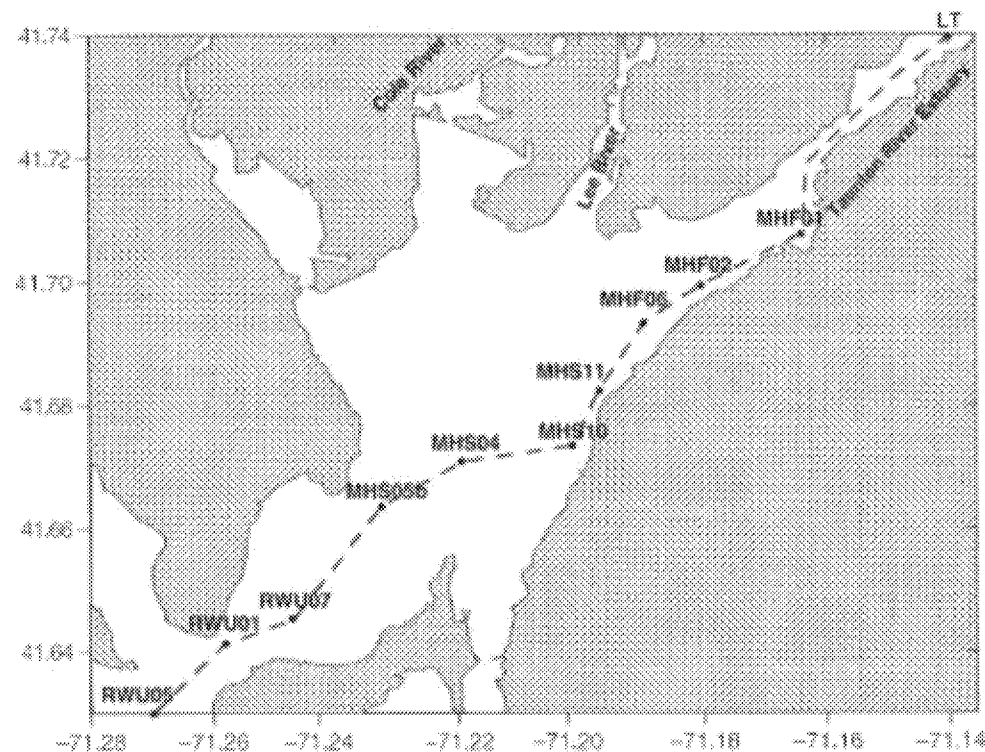


Fig. 13.5 Stations [Prell *et al.* (2004); Chapter 11] used to generate section views along the long axis of Mount Hope Bay. Station LT represents the MCZM autonomous monitoring site located in the Taunton River estuary during 1999–2003.

Source: Chap 11 & 13 in Desbonnet and Costa-Pierce, (2008)

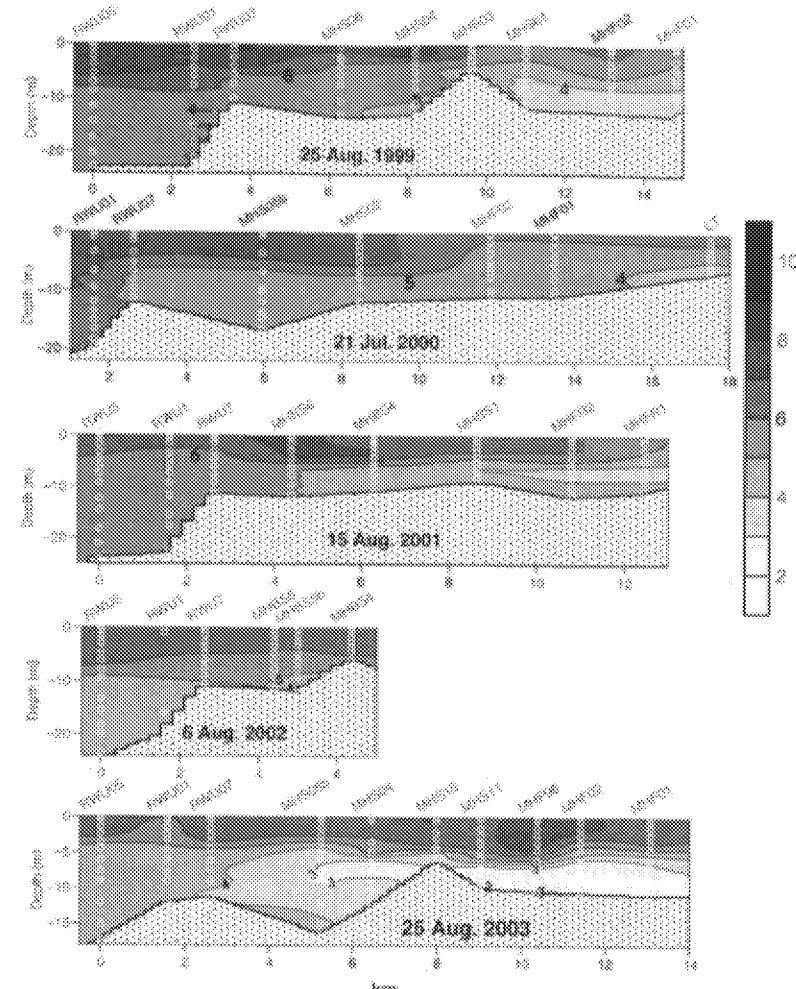


Fig. 13.6 S–N cross-sectional plots of the dissolved oxygen concentration field (milligram of O_2 per liter) in Mount Hope Bay for mid-late summer seasons, 1999–2003. Stations (see Chapter 11, and Fig. 13.5) used in each plot are shown. Open circles represent the samples taken at depths that were used to in interpolating each concentration field.

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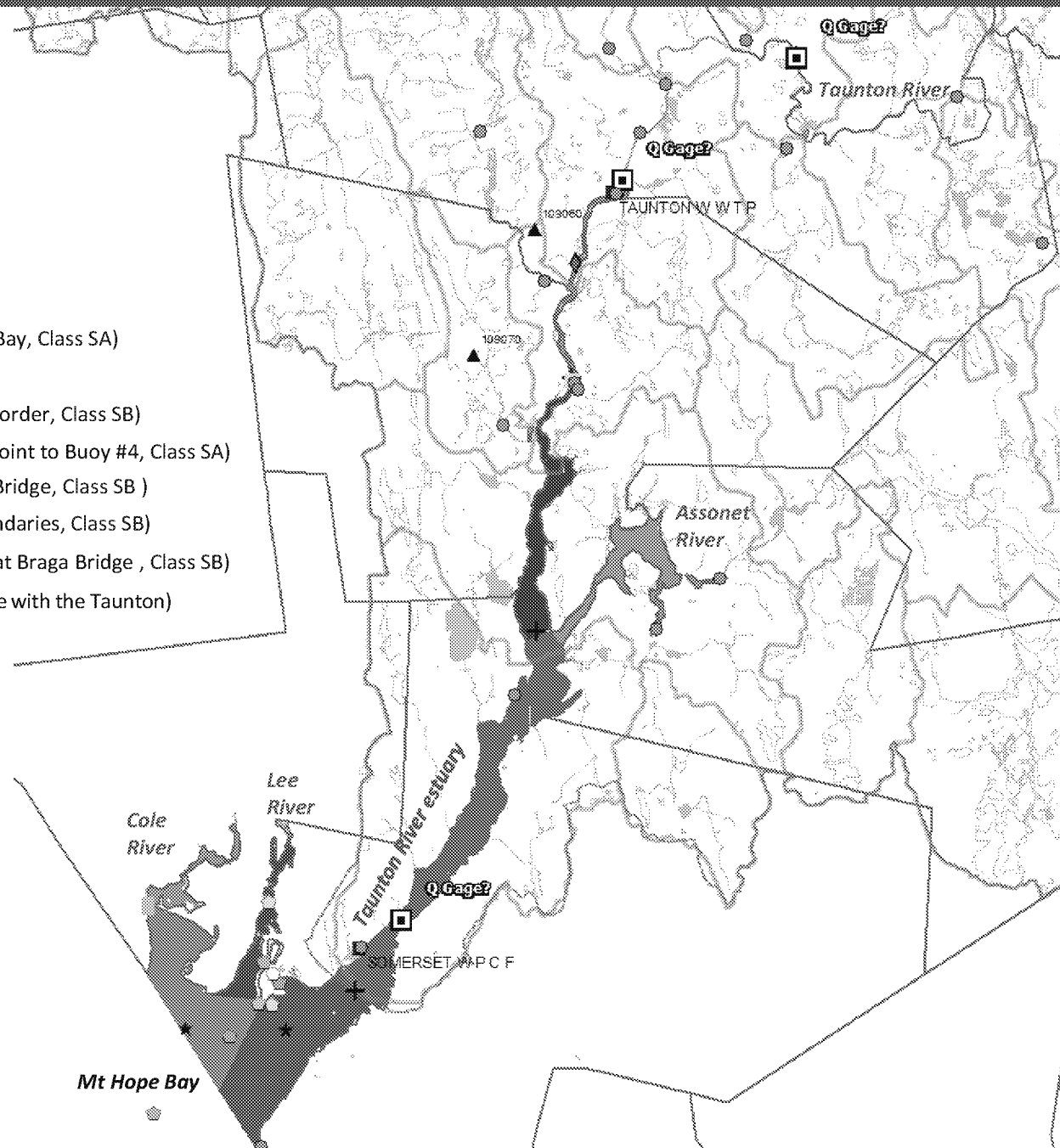
Taunton River and Mt Hope Bay

Assessment Units, Locations, and Class

MA61-01	Lee River (Lewin Brook to Route 6 , Class B
MA61-02	Lee River Segment (Route 6 into Mt. Hope Bay, Class SA)
MA61-04	Cole River (Route 6 to mouth, Class SA)
MA61-06	Mt. Hope Bay (Braga Bridge to the MA/RI border, Class SB)
MA61-07	Mt Hope Bay (west of a line from Brayton Point to Buoy #4, Class SA)
MA62-02	Taunton River (Route 24 Bridge to Berkley Bridge, Class SB)
MA62-03	Taunton River (Berkley Bridge to town boundaries, Class SB)
MA62-04	Taunton River (town boundaries to mouth at Braga Bridge , Class SB)
MA62-20	Assonet River (Tisdale Dam to the confluence with the Taunton)

Discrete QW Samples:

- Suspended Sediment Concentration
- Nutrients
- Bacteria
- Field parameters (DO, temp, SC, pH)



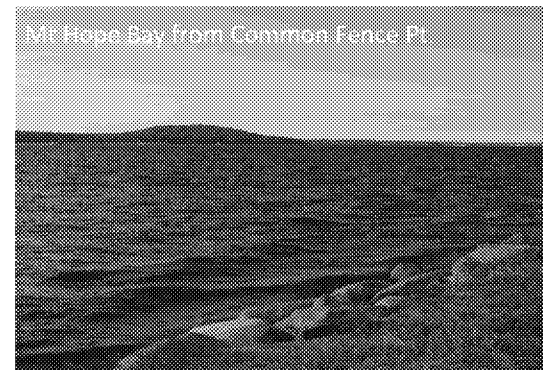
Mt. Hope Bay

KEY

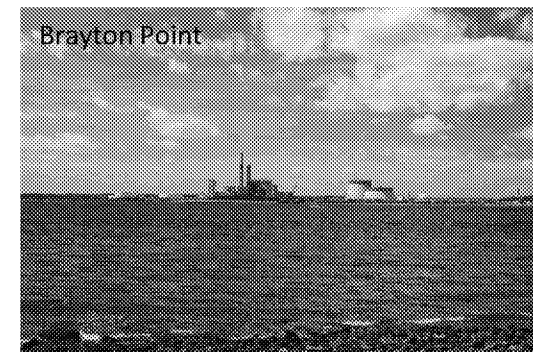


MHB13

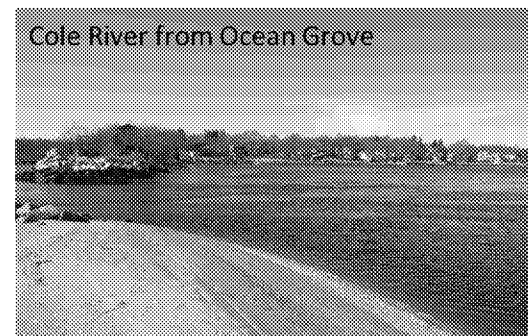
SMAS
sites



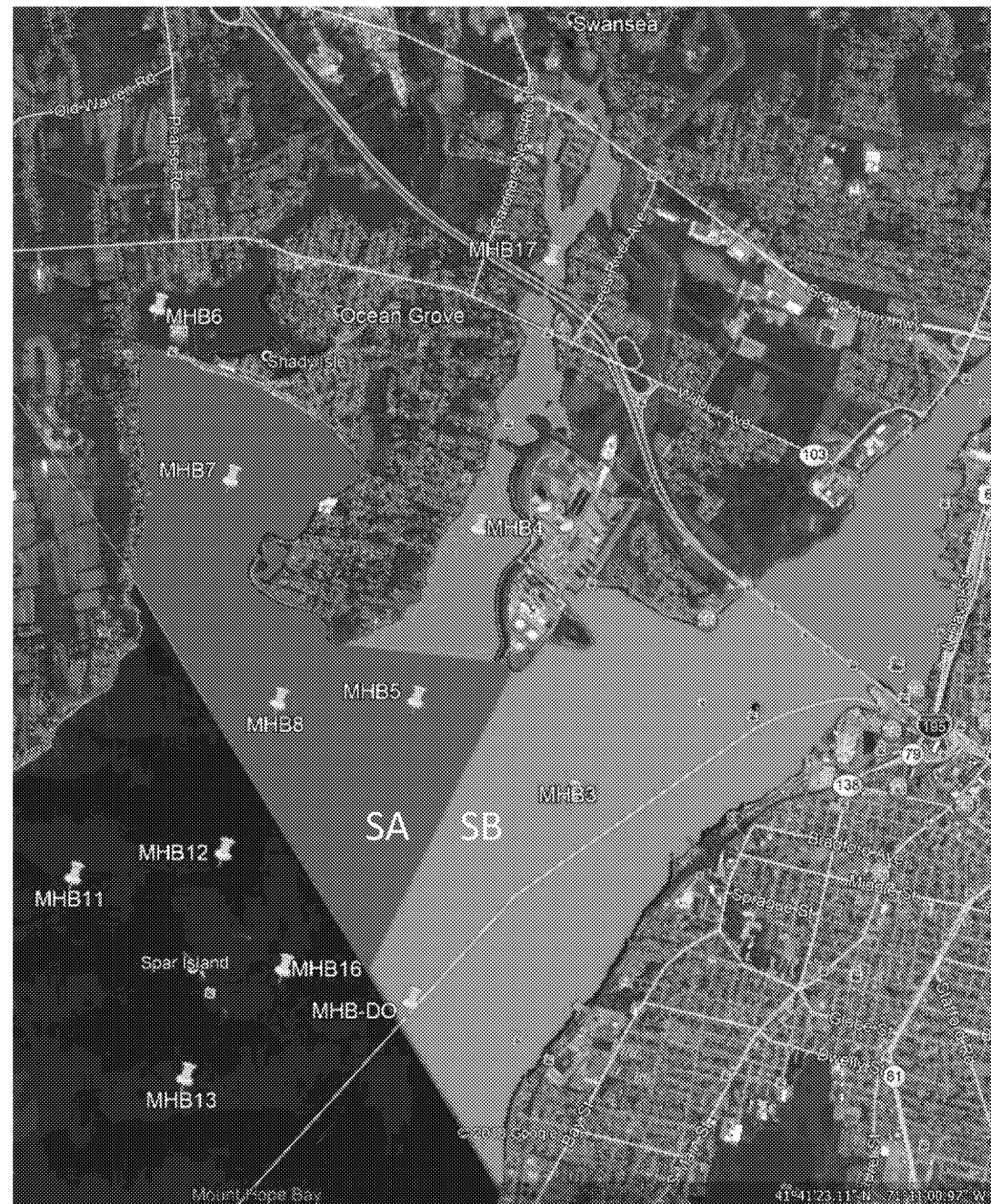
Mt Hope Bay from Common Fence Pt



Brayton Point

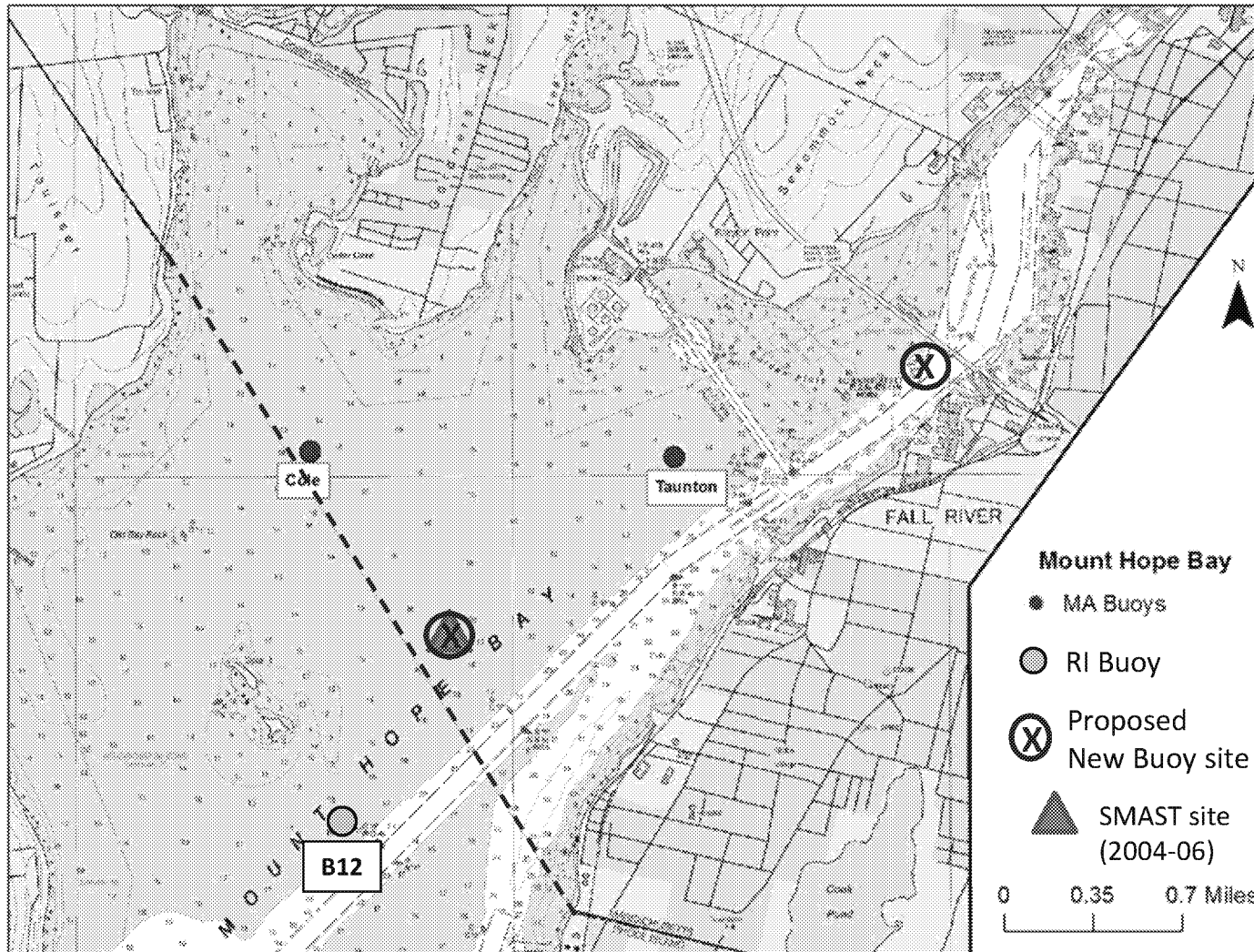


Cole River from Ocean Grove



(A) Additional buoys in Mount Hope Bay and the Taunton Estuary

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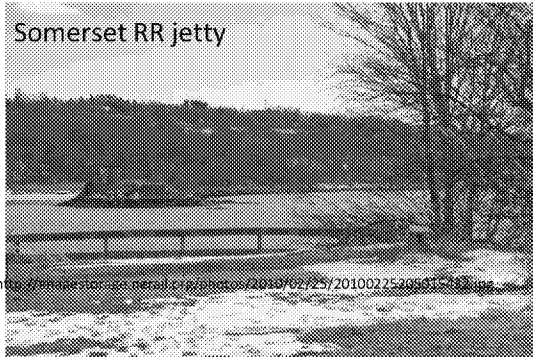
Lower Taunton Estuary

KEY



SMAST sites

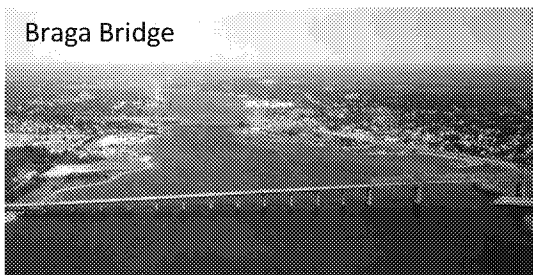
Somerset RR jetty



Veteren's Memorial Bridge



Braga Bridge



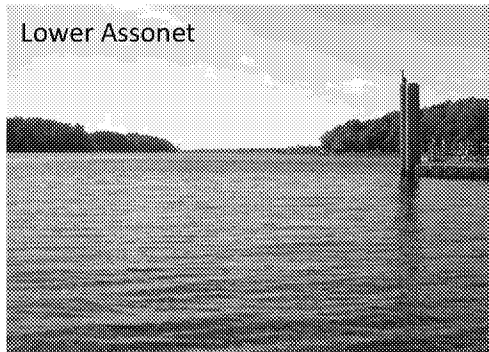
Additional buoys in Mount Hope Bay and the Taunton Estuary...

3. An additional buoy in the middle Taunton Estuary, downstream of the mouth of the Assonet and (between the Somerset and Taunton) WWTF

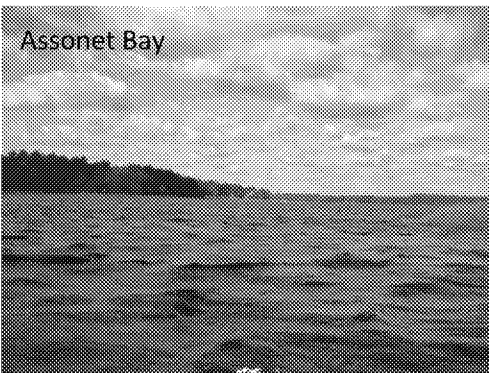


Assonet

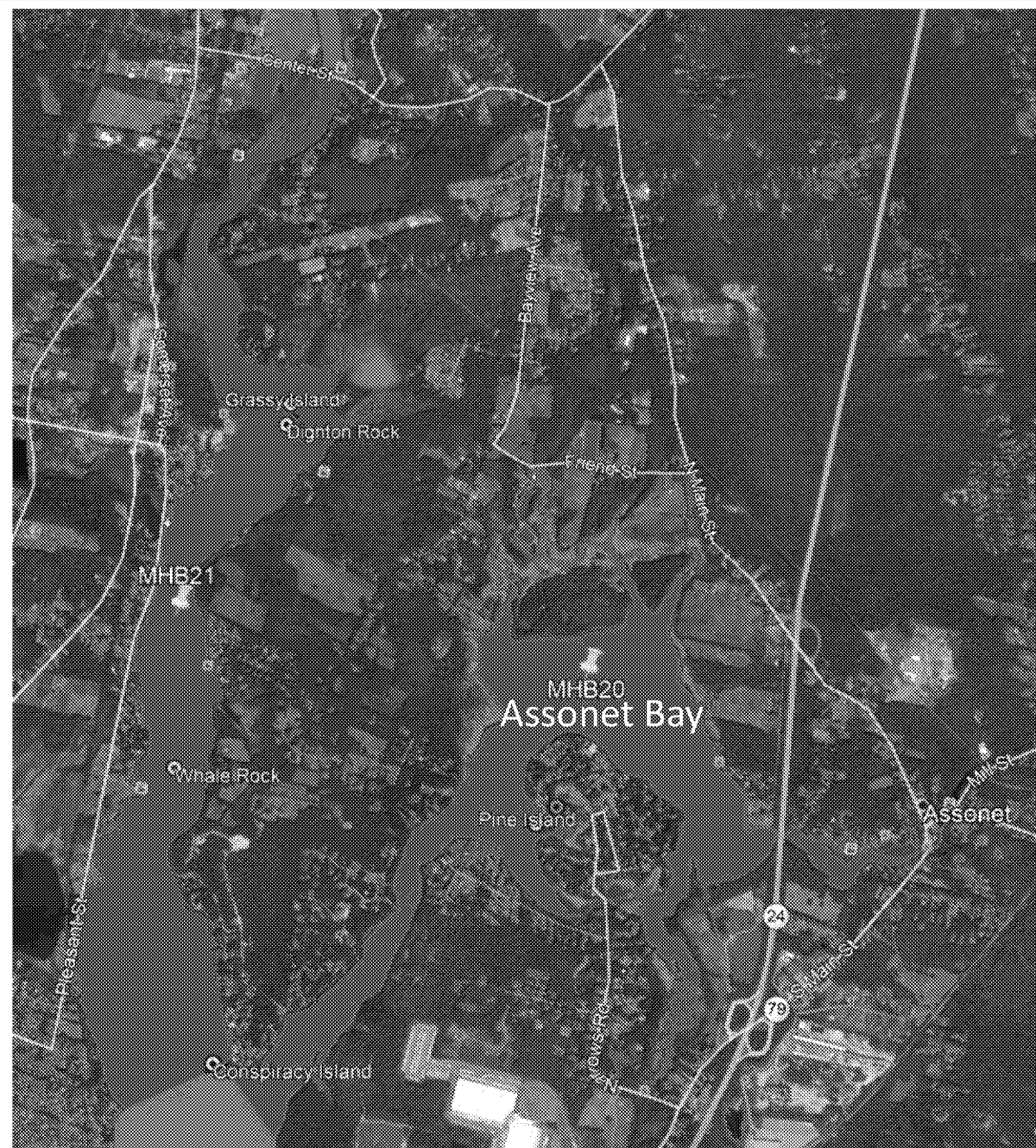
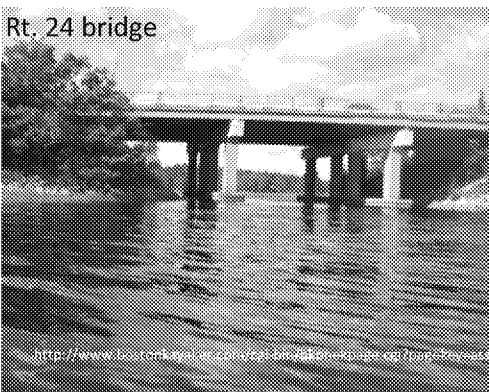
Lower Assonet



Assonet Bay



Rt. 24 bridge

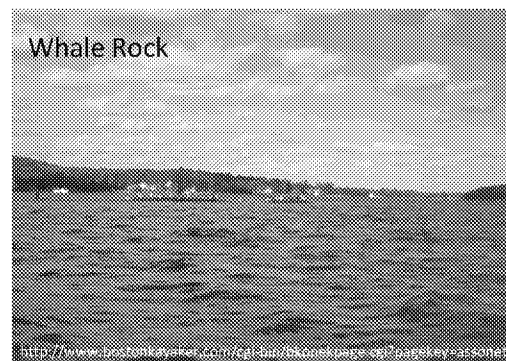


Middle Taunton Estuary

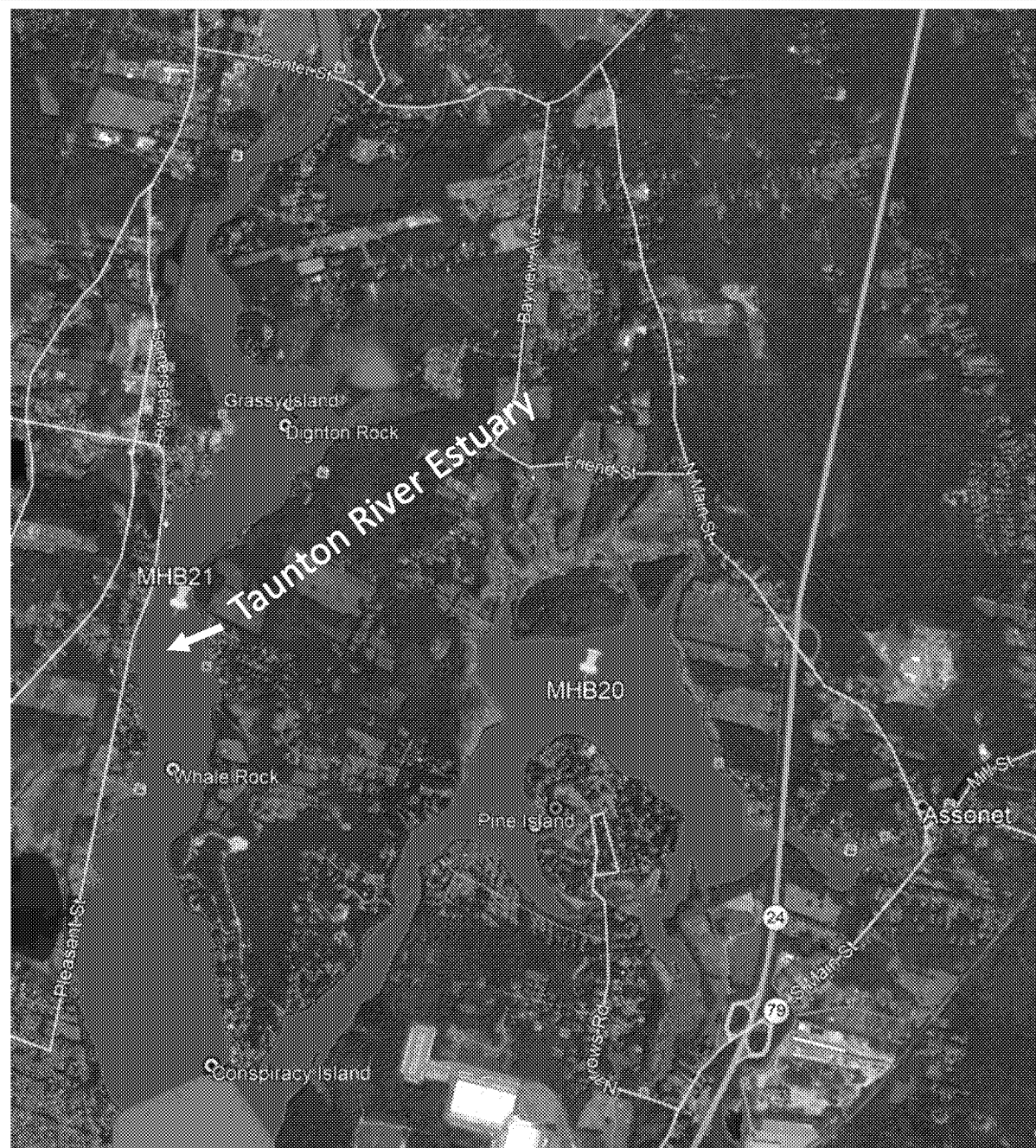
Dighton Museum



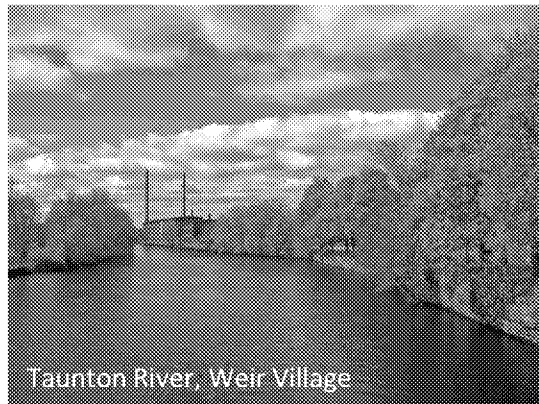
Whale Rock



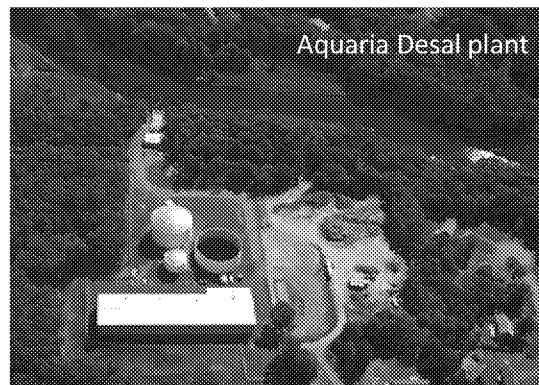
Conspiracy Island



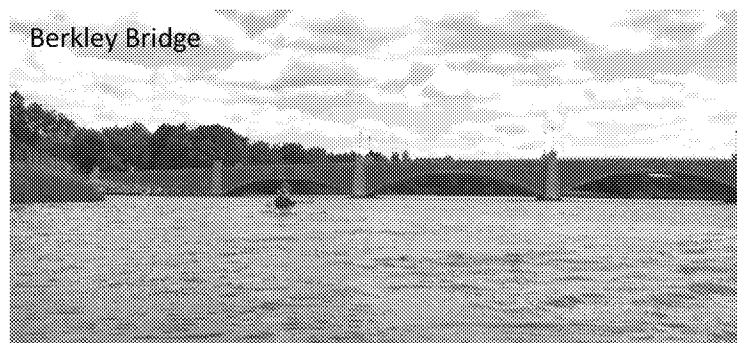
Upper Taunton Estuary



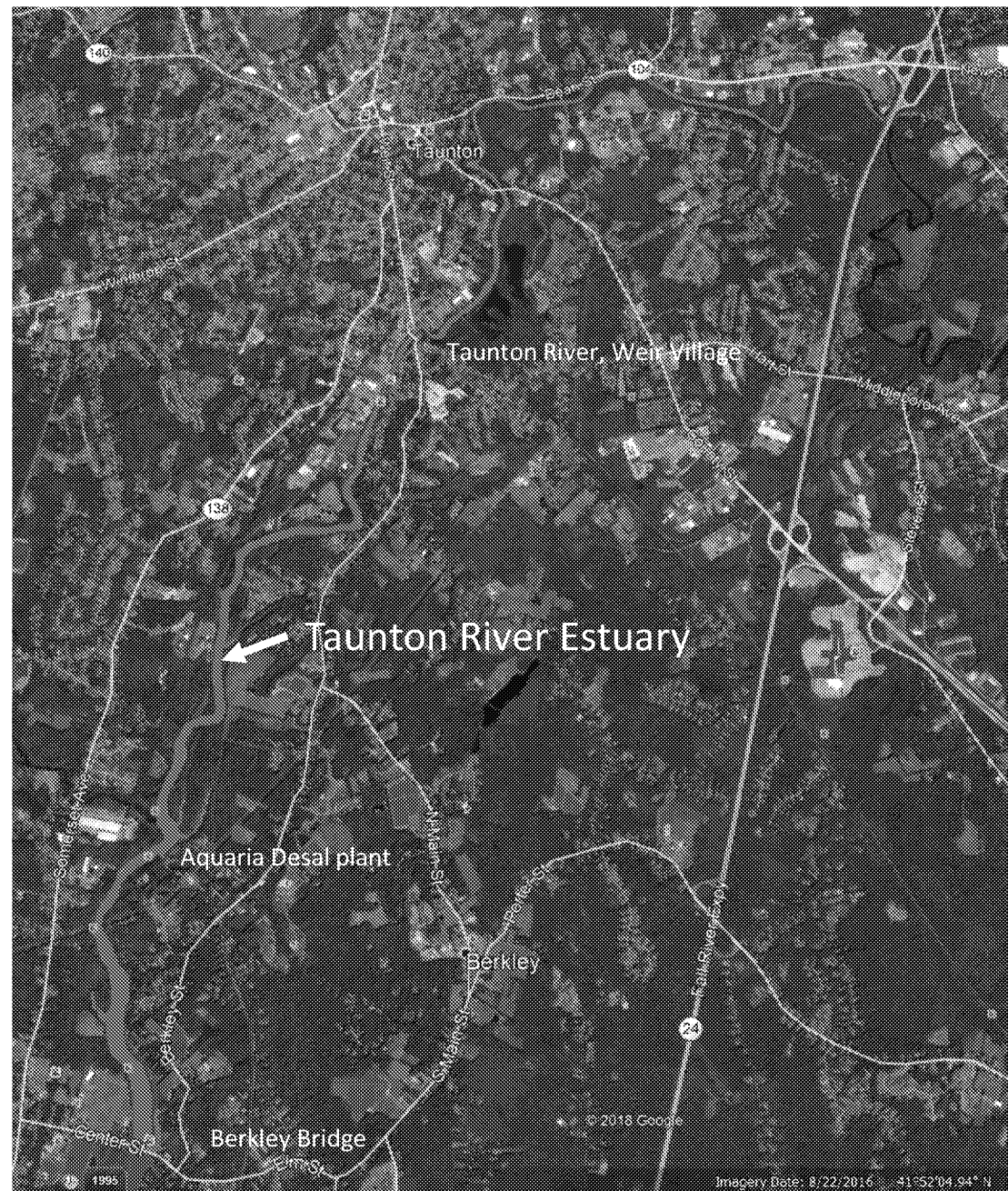
Taunton River, Weir Village



Aquaria Desal plant



Berkley Bridge



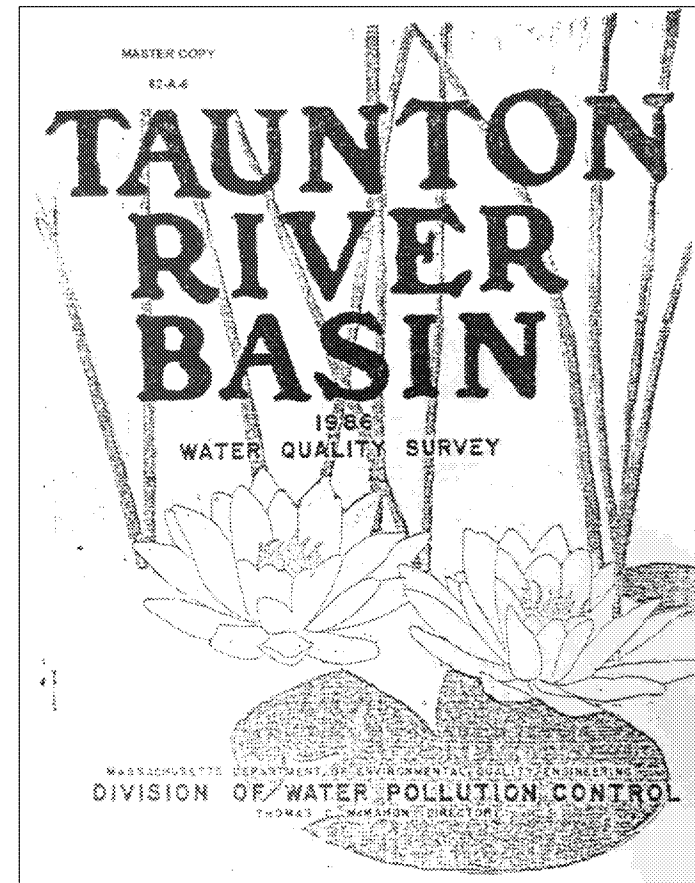
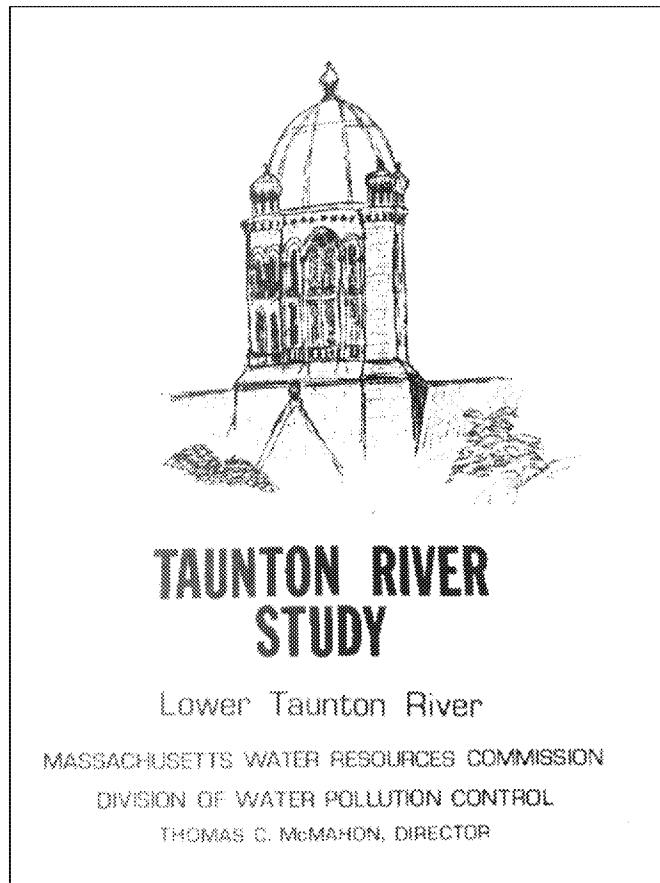
Imagery Date: 8/22/2016 41°52'04.94" N 71°52'04.94" W

4. An additional buoy or sensor in the upper Taunton Estuary near the saltwater-freshwater interface (and upstream of the Taunton WWTF)



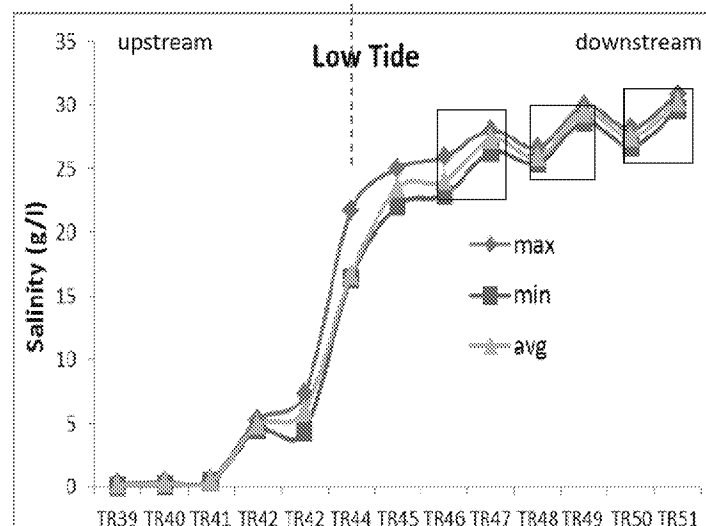
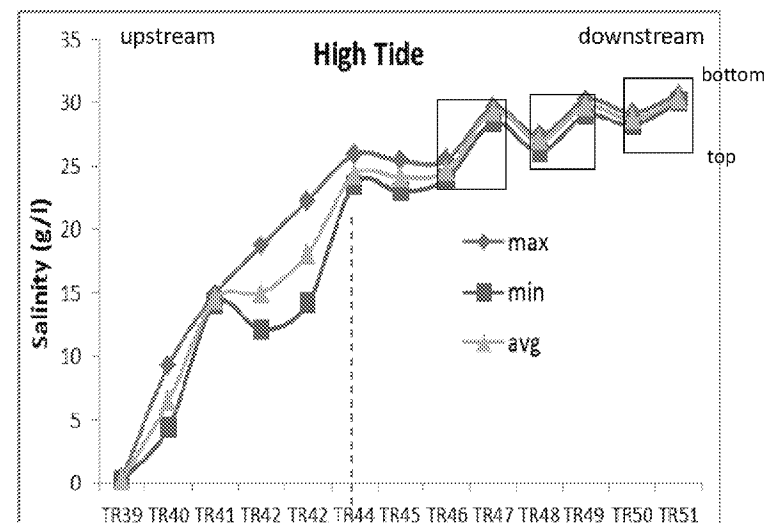
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2. Assessment of waterbody compliance to water-quality standards
- 3. Delineate upper boundary of salt wedge in Taunton estuary**
4. Estimate nutrient loads into Taunton estuary

- MassDEP documented the salinity gradient of the salt wedge along the lower Taunton in 1970, and again in 1986





The 1970 survey documented the salinity gradient at 10 sites. Salinity drops off rapidly as the Taunton narrows US of the Assonet



- The 1986 survey documented the salinity gradient at 7 sites.

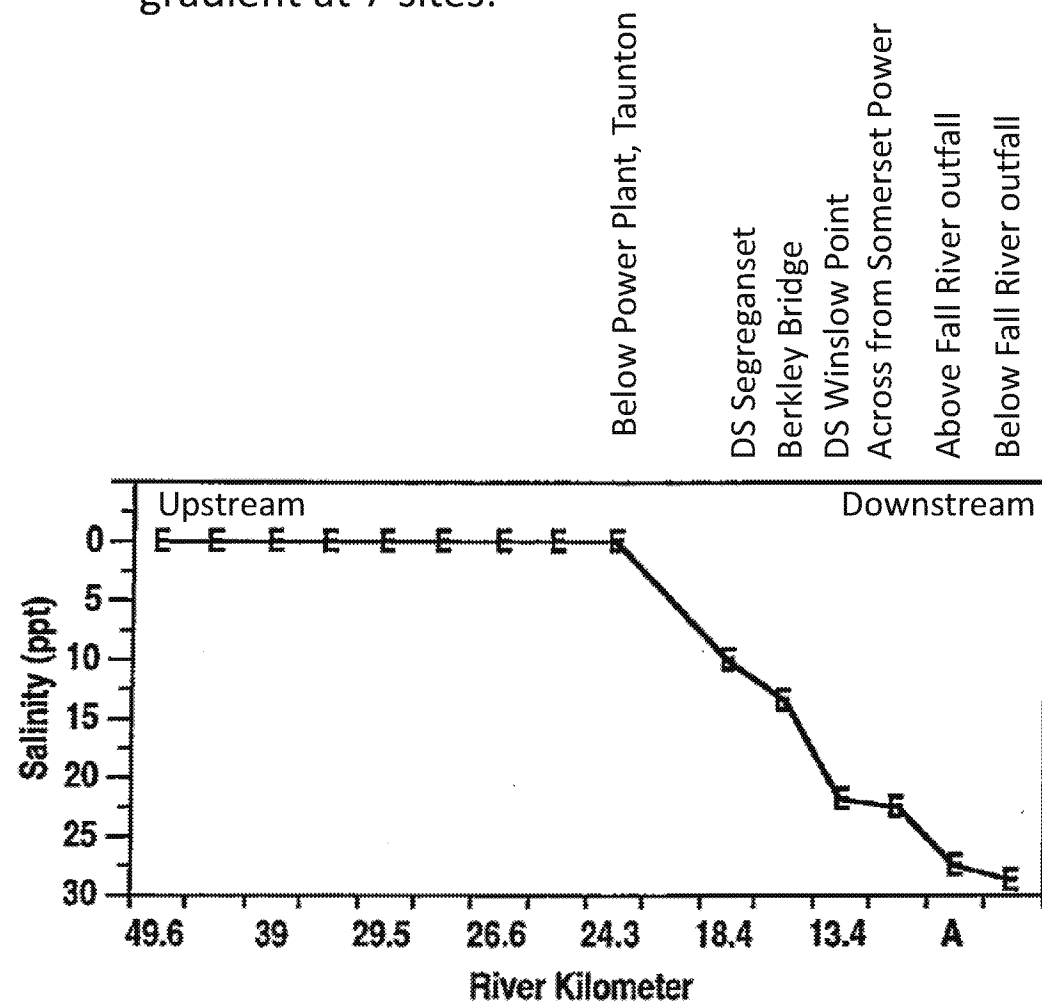
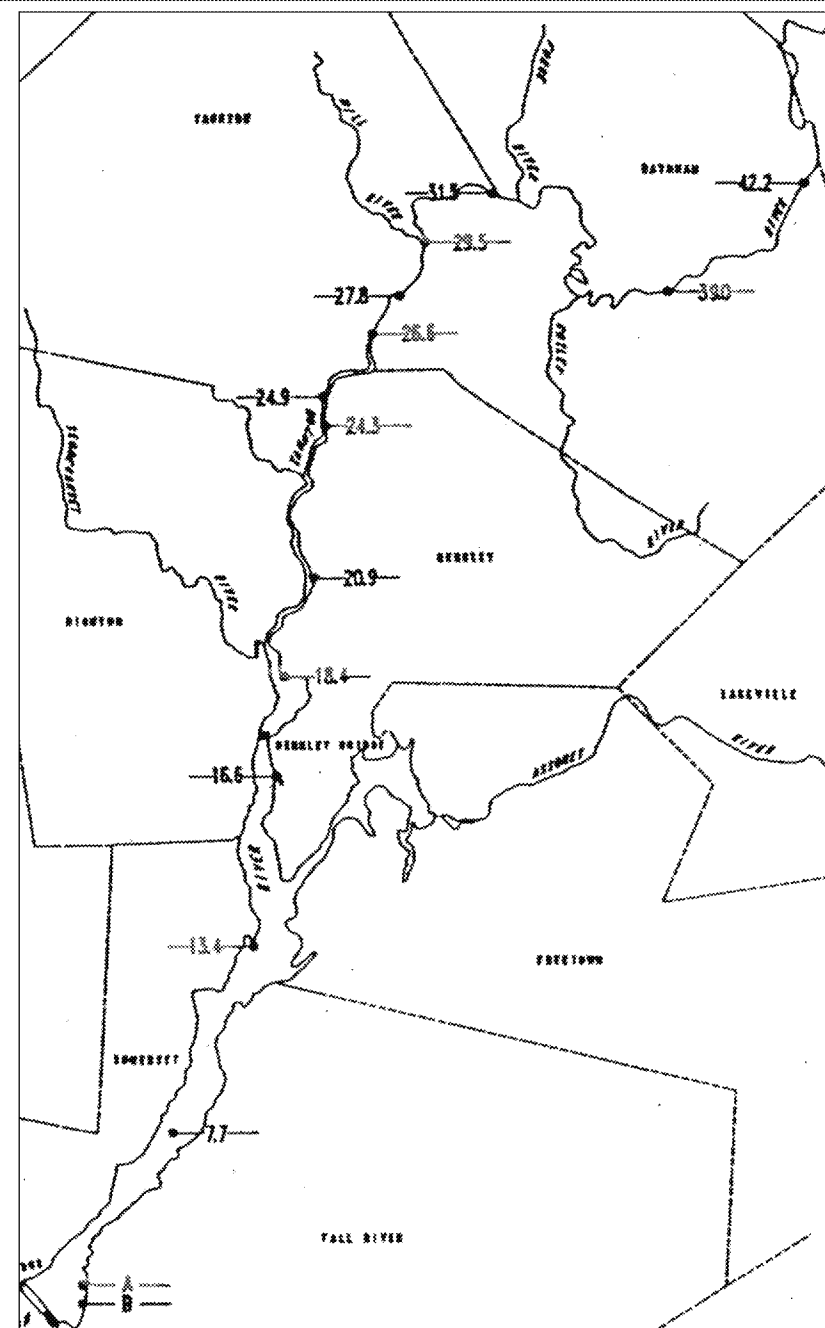


Figure 5. Surface salinity along a down estuary transect during July of 1986, showing a rapid mixing of the water column during July once within the tidal portion of the river. The pattern suggests that a salt wedge is present and that density stratification of the water column is occurring. Data from Dorfman (1989). A is above the Fall River STP discharge site, B is below.

- The goal of the data collection would be to repeat analyses at the same stations as in the 1970 survey
- As done in 1986, data would be collected at additional sites upstream to document background conditions for potential future changes in the salt wedge owing to storm surges and sea-level rise

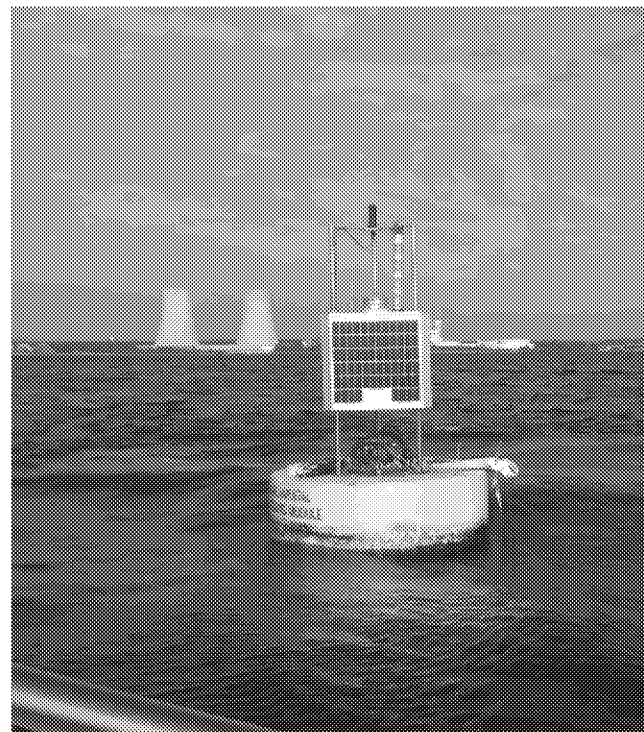
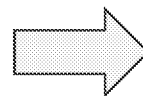
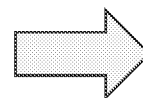
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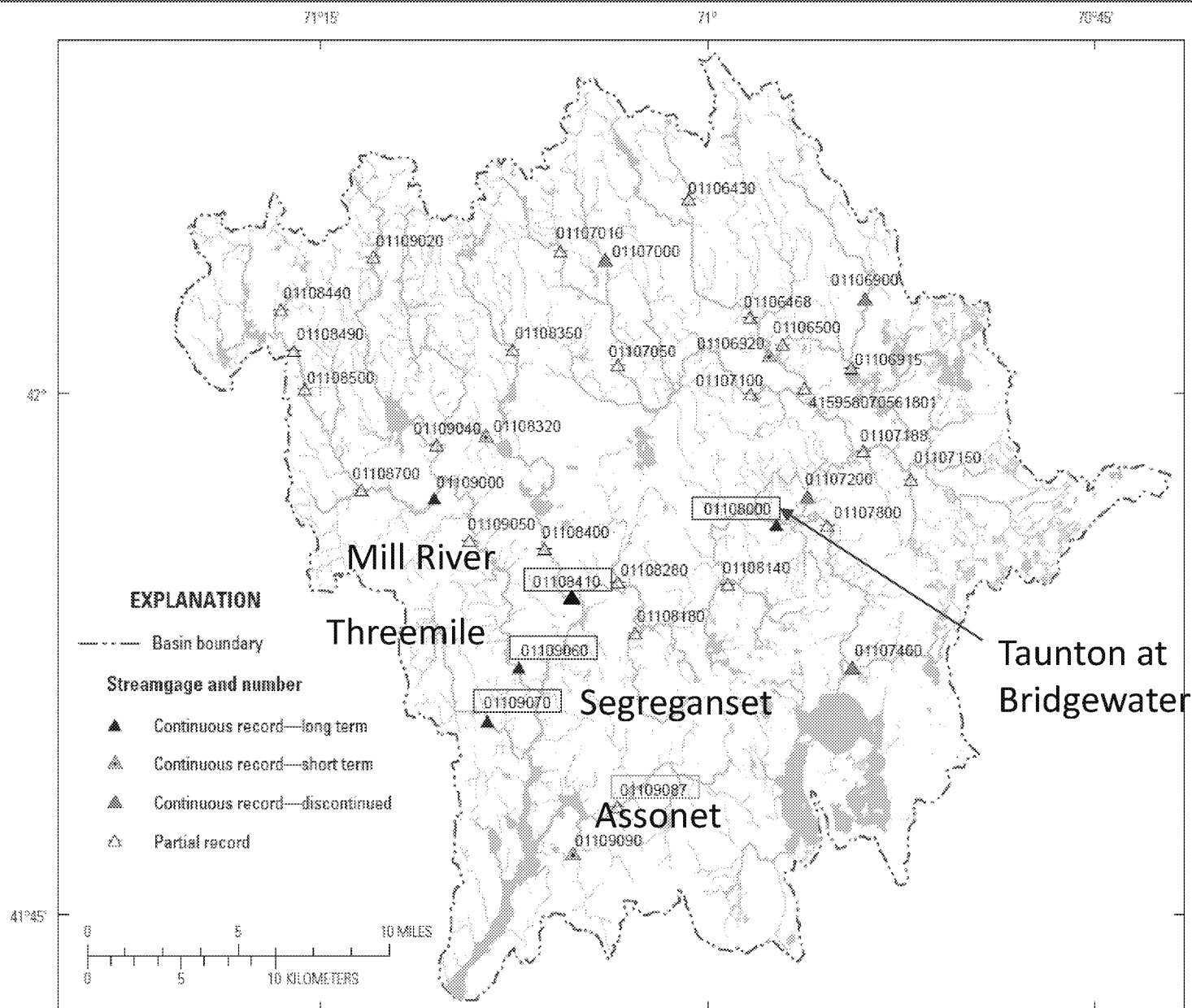
Estimate nutrient loads into estuary

input variables to understand Mt. Hope Bay responses

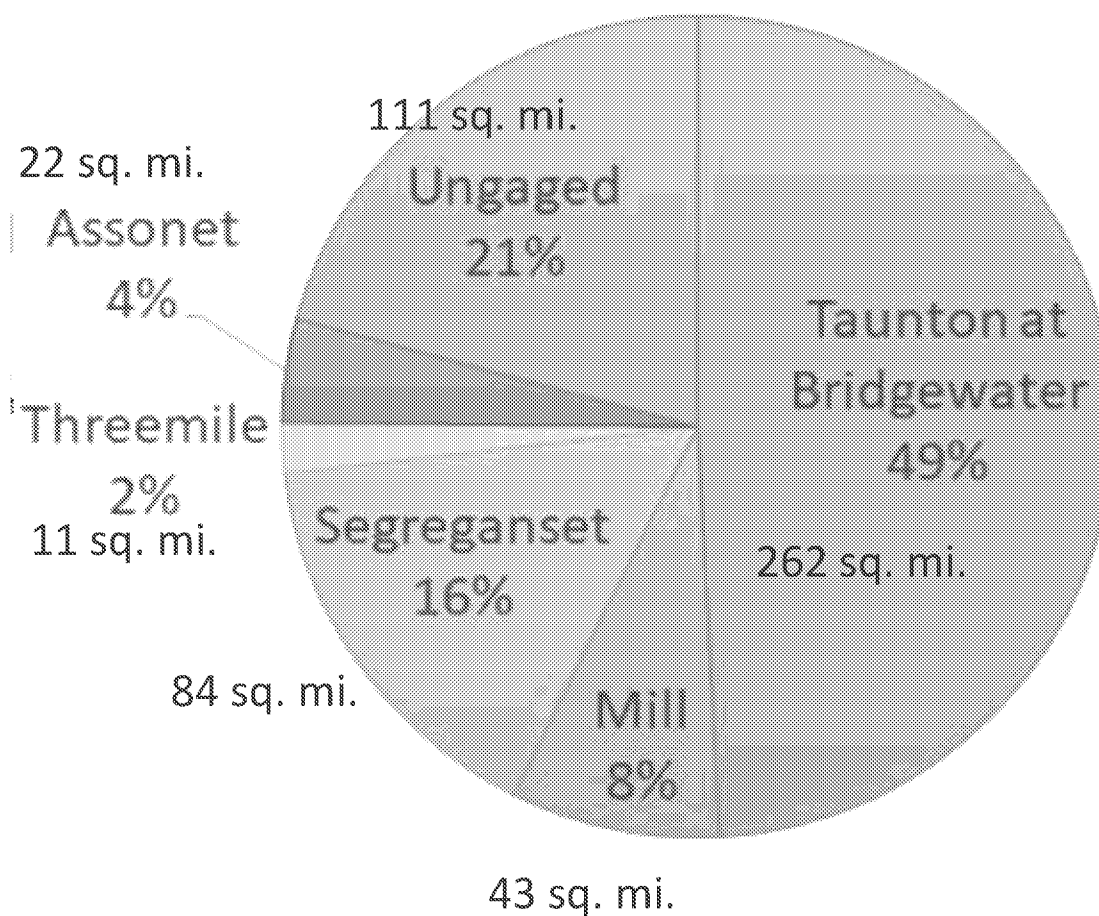
Characterize sources

1. Monitoring at existing gages
2. New station below Taunton





Base from U.S. Geological Survey digital data

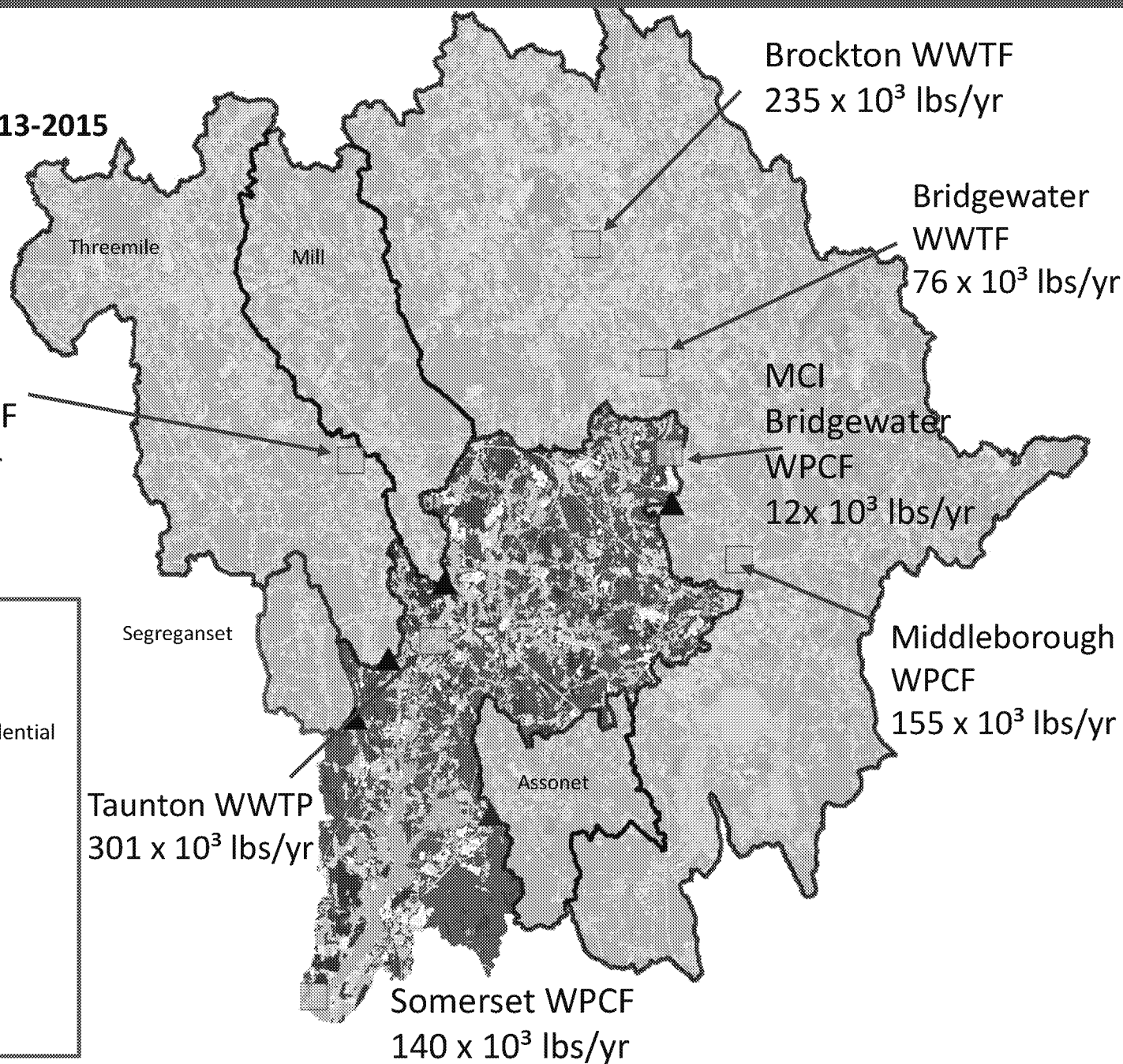
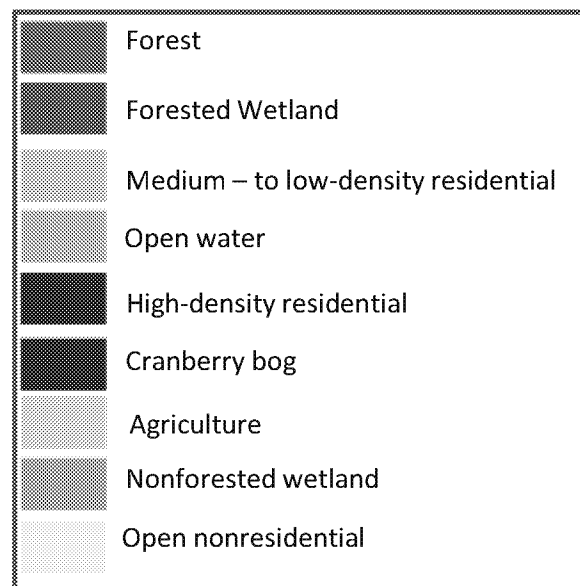


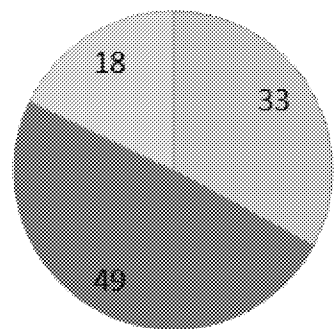
Key:

Facility Name

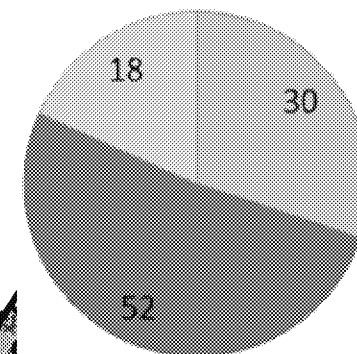
Total Nitrogen Loading, 2013-2015

Source: NBEP, 2017

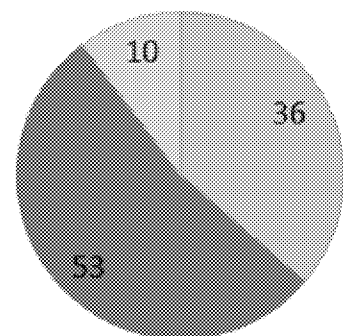




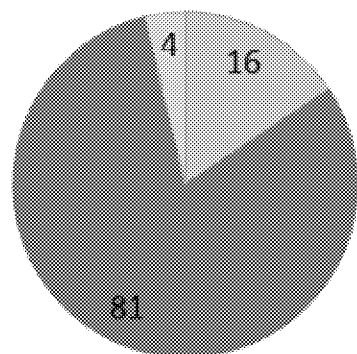
Mill



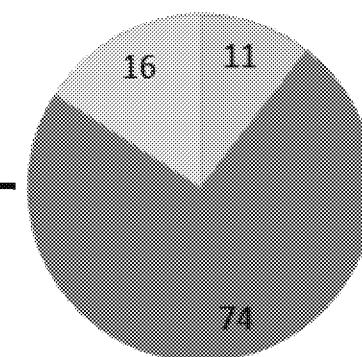
Taunton @
Bridgewater



Threemile



Segreganset



Assonet

■ % Developed

■ % Forested

■ % Other

Frequency

- Bi-weekly or monthly discrete sampling
- Sample across the flow-duration curve
 - Targeted sampling frequency can reduce sampling duration

Duration

- Minimum 1-2 years
- Dependent on frequency

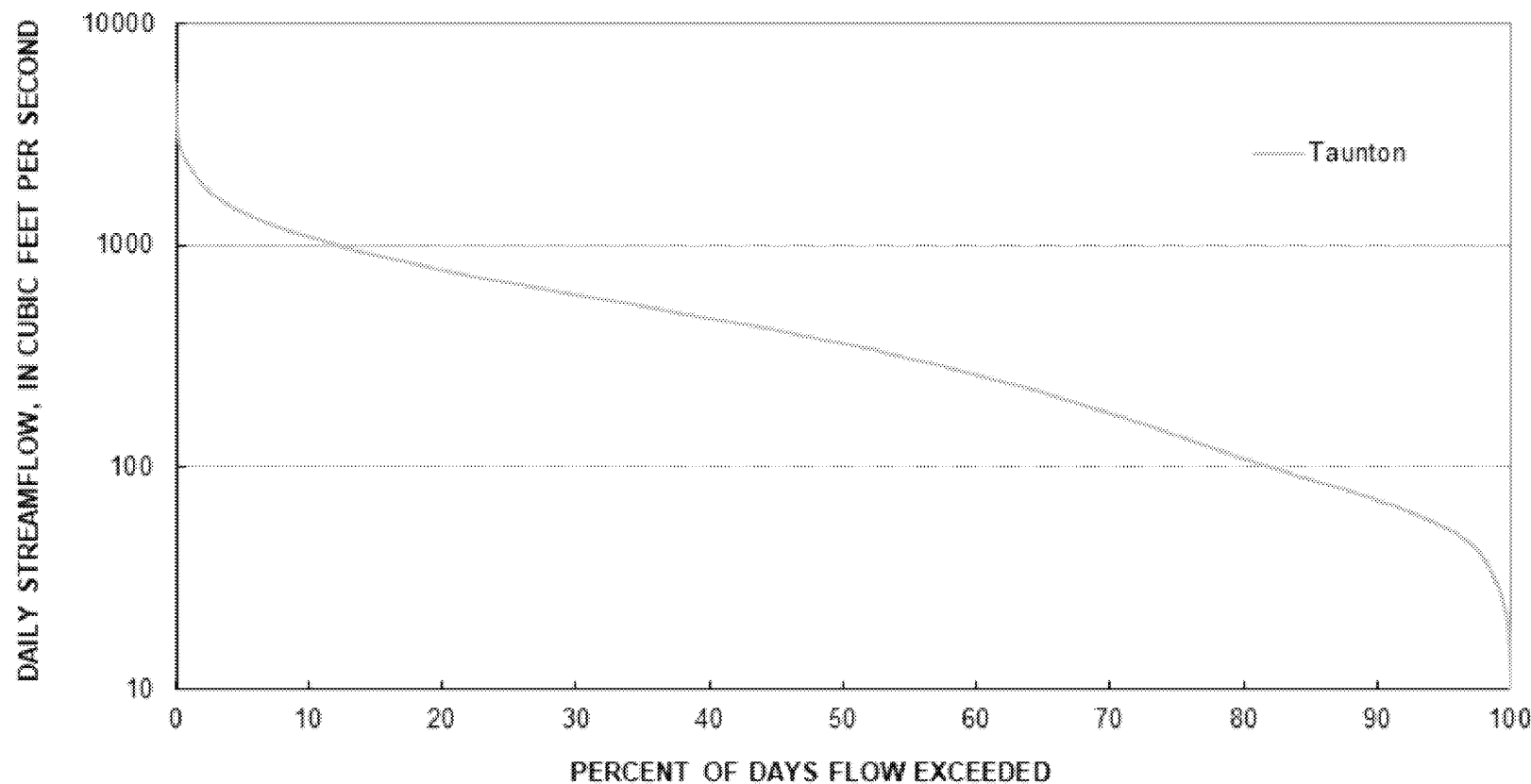
Locations

- Co-locate with existing gaging stations
- Subbasins of interest

Constituents

- Nitrogen (Total, dissolved)
- *Phosphorus (total, dissolved)*
- *Suspended Sediment Concentration*

Flow-Duration Curve, Taunton @ Bridgewater 01108000



Based on daily mean flow 1929-
2017

ED_002331_00007471-00039

LOADEST

develop regression model to estimate load using instantaneous concentration and daily streamflow

Potential Explanatory Variables

- functions of streamflow
- decimal time
- seasonal terms
- user-specified data (other continuous records at the site)

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Results

- Annual nutrient loads at 4-5 subbasins in Taunton Basin

LOADEST

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Potential Explanatory Variables

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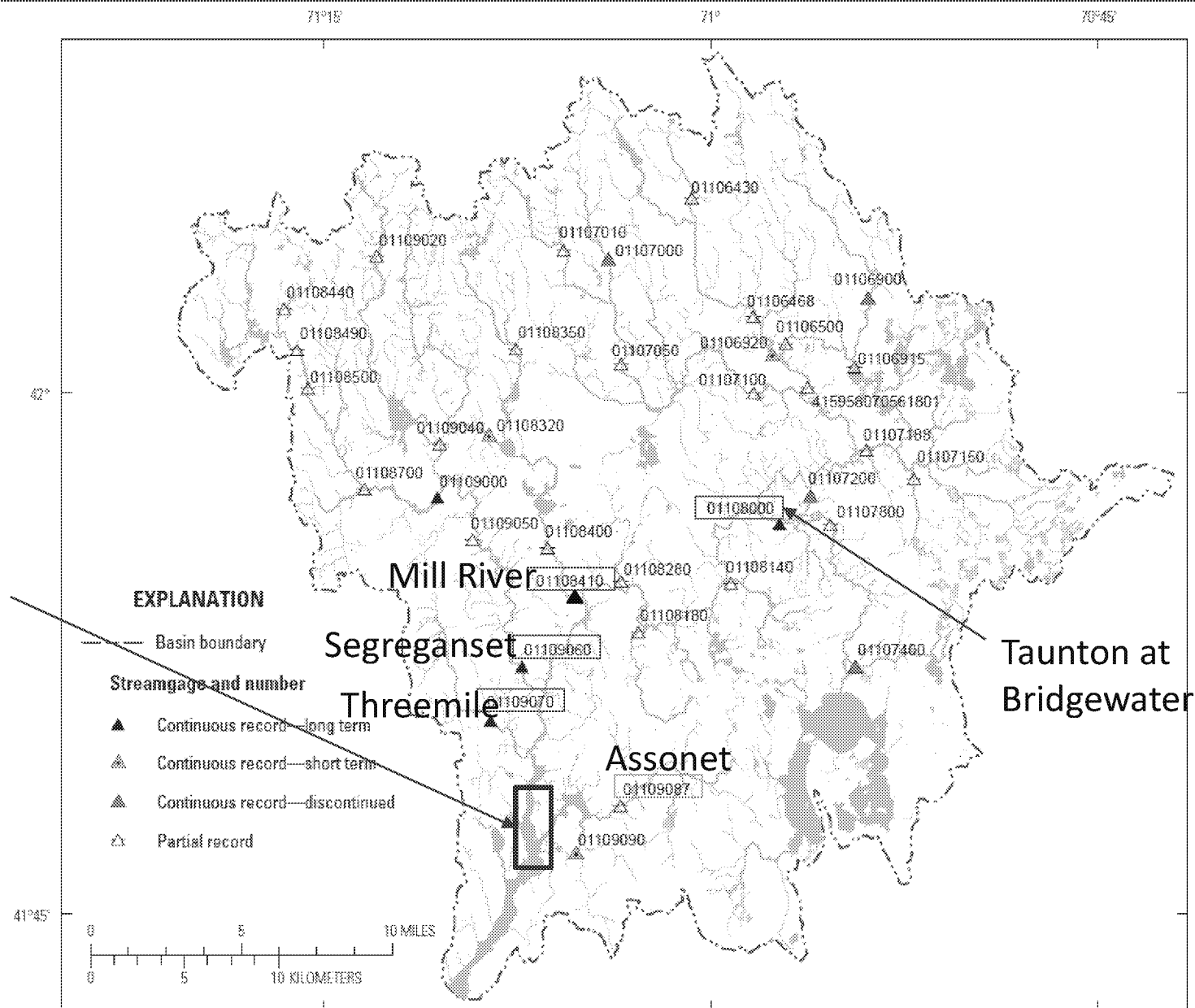
Results

- Annual nutrient loads at 4-5 subbasins in Taunton Basin

Benefits

- Help identify management priorities & measure response
- Apportion loading to point/non-point sources on subbasin scale
- Provide model input data (future modeling)

**New
gage**



Base from U.S. Geological Survey digital data



Monitoring:

15-minute data:

- Flow
- Physical parameters

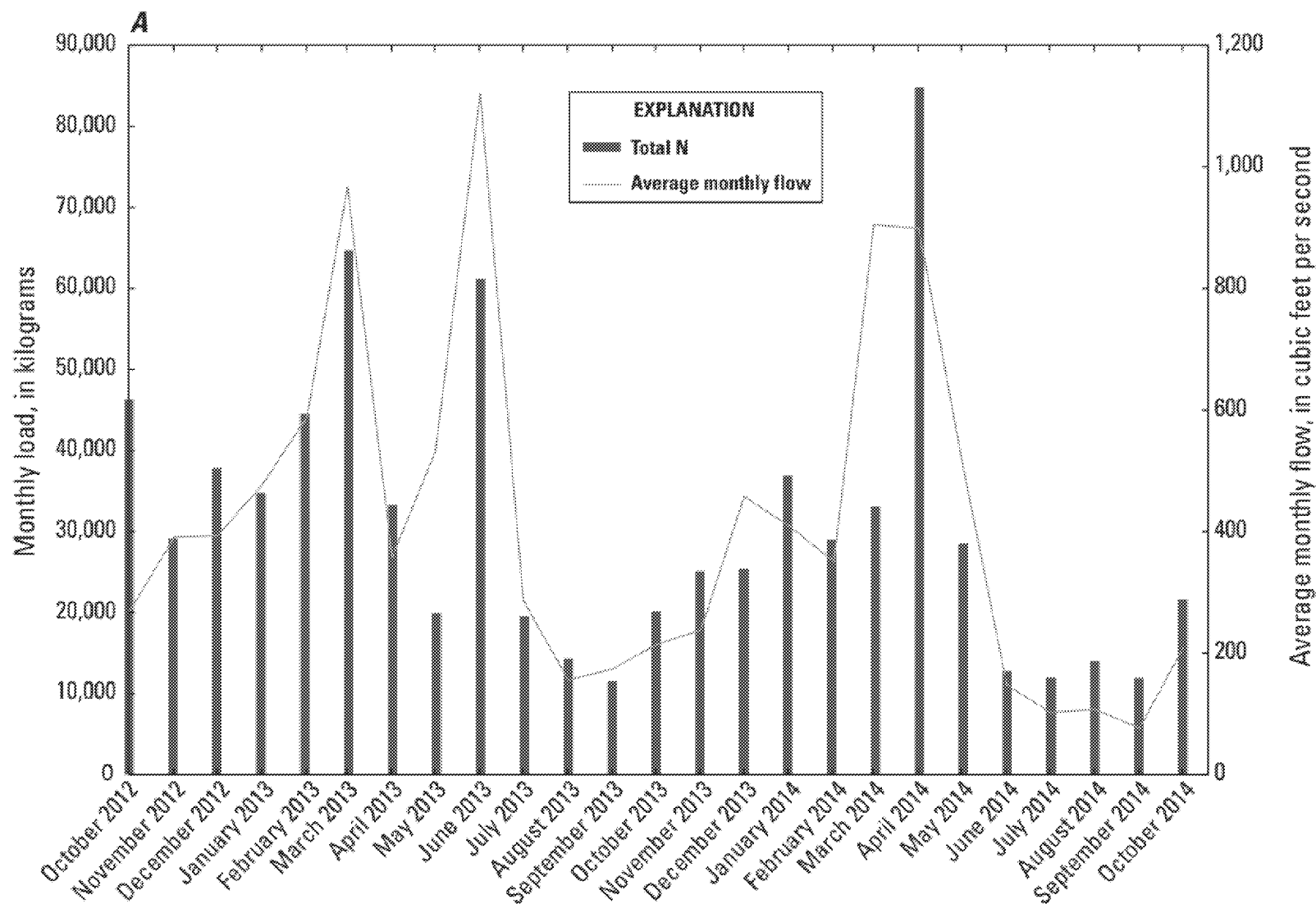
Flow-proportional automated sample collection:

14 day composites

- Nitrogen
- Phosphorus
- Majors and trace elements

Separate inflow and outflow tide

Results

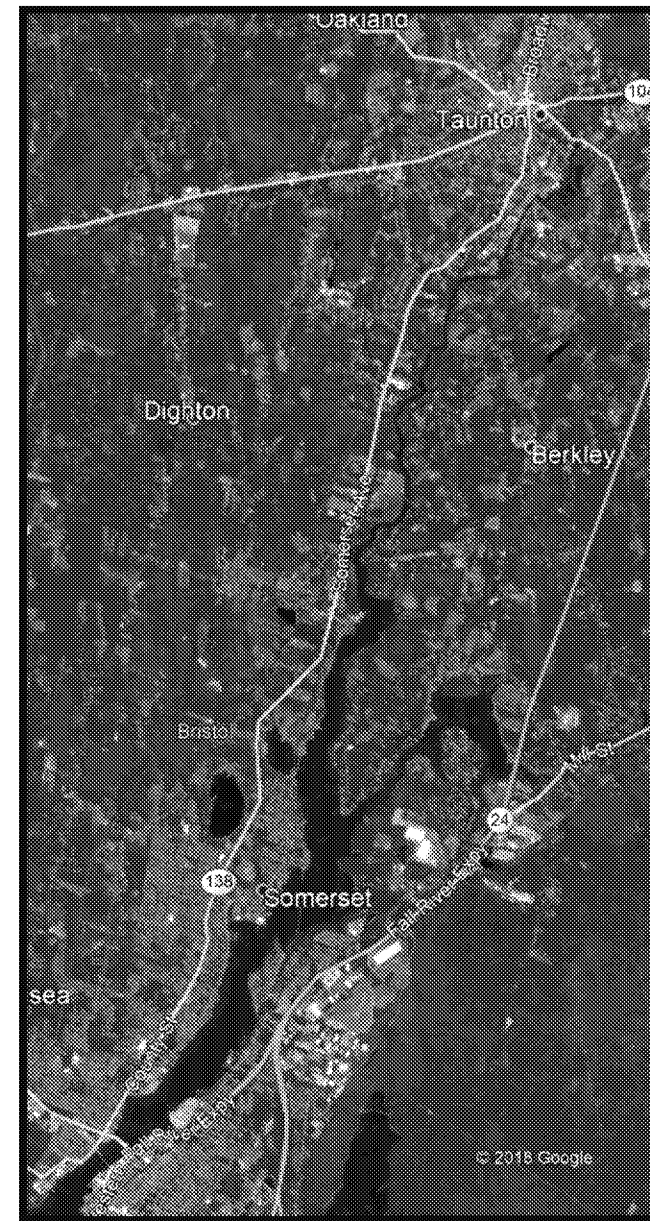


Benefits

- maximize gaged drainage area
- maximize accuracy on load calculation
- Provide model input data (future modeling)

Results

- monthly nutrient loads for sampling period (1+ years)
- net flux at site (inflow and outflow loads)
- continuous record



Two approaches:

1. Monitor at existing subbasin gages

- Discrete sampling
- LOADEST regression model for annual loads
- Capture inputs to estuary from major subbasins

2. New composite station in Taunton estuary

- 14 day nutrient composite samples
- Measure monthly loads
- Capture inputs to Mt. Hope Bay from Taunton basin



Questions?

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Alana Spaetzel

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B. Taunton River at Titicut Street, Bridgewater

